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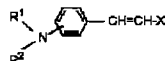
(54) 【発明の名称】 有機電界発光素子

(57) 【要約】

【課題】 安定かつ発光輝度の大きい赤色発光の有機電  
 界発光素子を提供すること。

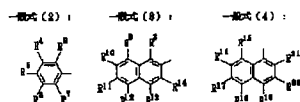
【解決手段】 発光領域を有する有機層5、5a、5b  
 に下記一般式(1)で表されるスチリル化合物の少なく  
 とも1種が含まれていることを特徴とする、有機電界発  
 光素子。

【化74】 一般式(1)：

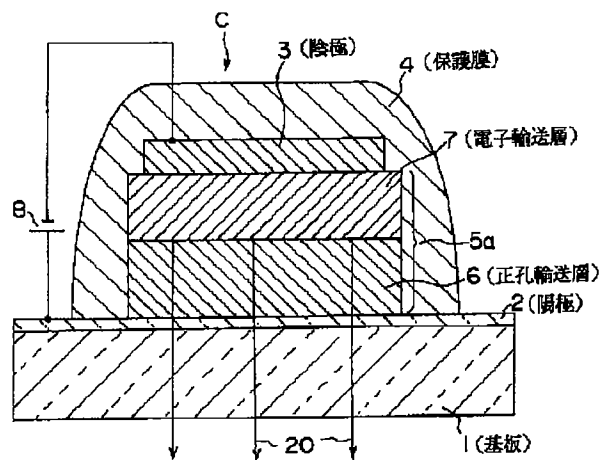


〔但し、R<sup>1</sup> 及び R<sup>2</sup> は下記一般式(2)、(3)又は  
 (4)で表わされるアリール基であり

【化75】



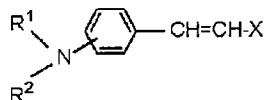
〔但し、R<sup>3</sup> ~ R<sup>21</sup>は水素原子、メトキシ基等の特定の  
 置換基)、Xは置換又は無置換のアリール基又は炭化水  
 素環基である。〕



【特許請求の範囲】

【請求項1】 発光領域を有する有機層が陽極と陰極との間に設けられている有機電界発光素子において、前記有機層に下記一般式（1）で表される非対称構造のstyril化合物の少なくとも1種が有機発光材料として含まれていることを特徴とする、有機電界発光素子。

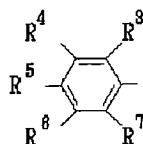
【化1】一般式（1）：



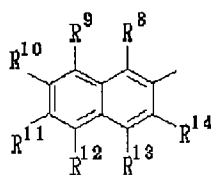
〔但し、前記一般式（1）において、R<sup>1</sup> 及びR<sup>2</sup> は互いに同一の又は異なる基であって、下記一般式（2）、（3）又は（4）で表わされるアリール基であり

【化2】

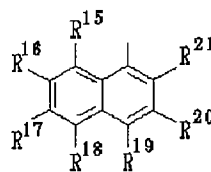
一般式（2）：



一般式（3）：



一般式（4）：

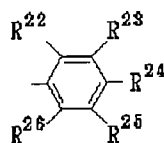


〔但し、前記一般式（2）、（3）及び（4）において、R<sup>3</sup>、R<sup>4</sup>、R<sup>5</sup>、R<sup>6</sup>、R<sup>7</sup>、R<sup>8</sup>、R<sup>9</sup>、R<sup>10</sup>、R<sup>11</sup>、R<sup>12</sup>、R<sup>13</sup>、R<sup>14</sup>、R<sup>15</sup>、R<sup>16</sup>、R<sup>17</sup>、R<sup>18</sup>、R<sup>19</sup>、R<sup>20</sup>及びR<sup>21</sup>は互いに同一の又は異なる基であって、水素原子、飽和又は不飽和アルコキシル基、アルキル基、アミノ基、アルキルアミノ基又はアリール基である。）、Xは置換又は無置換のアリール基又は炭化水素環基である。〕

【請求項2】 前記一般式（1）におけるXが下記一般式（5）で表される、請求項1に記載した有機電界発光素子。

【化3】

一般式（5）：



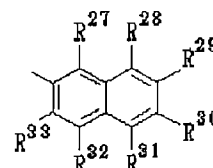
〔但し、前記一般式（5）において、R<sup>22</sup>、R<sup>23</sup>、

て、それらの少なくとも1つがシアノ基、ニトロ基又はハロゲン原子である。〕

【請求項3】 前記一般式（1）におけるXが下記一般式（6）で表される、請求項1に記載した有機電界発光素子。

【化4】

一般式（6）：

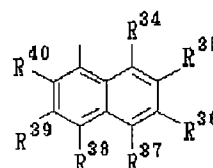


〔但し、前記一般式（6）において、R<sup>27</sup>、R<sup>28</sup>、R<sup>29</sup>、R<sup>30</sup>、R<sup>31</sup>、R<sup>32</sup>及びR<sup>33</sup>は互いに同一の又は異なる基であって、水素原子、或いはそれらの少なくとも1つがシアノ基、ニトロ基又はハロゲン原子である。〕

【請求項4】 前記一般式（1）におけるXが下記一般式（7）で表される、請求項1に記載した有機電界発光素子。

【化5】

一般式（7）：

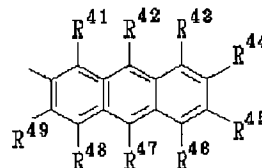


〔但し、前記一般式（7）において、R<sup>34</sup>、R<sup>35</sup>、R<sup>36</sup>、R<sup>37</sup>、R<sup>38</sup>、R<sup>39</sup>及びR<sup>40</sup>は互いに同一の又は異なる基であって、水素原子、或いはそれらの少なくとも1つがシアノ基、ニトロ基又はハロゲン原子である。〕

【請求項5】 前記一般式（1）におけるXが下記一般式（8）で表される、請求項1に記載した有機電界発光素子。

【化6】

一般式（8）：

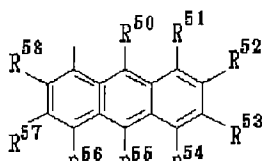


〔但し、前記一般式（8）において、R<sup>41</sup>、R<sup>42</sup>、R<sup>43</sup>、R<sup>44</sup>、R<sup>45</sup>、R<sup>46</sup>、R<sup>47</sup>、R<sup>48</sup>及びR<sup>49</sup>は互いに同一の又は異なる基であって、水素原子、或いはそれらの少なくとも1つがシアノ基、ニトロ基又はハロゲン原子である。〕

【請求項6】 前記一般式（1）におけるXが下記一般式（9）で表される、請求項1に記載した有機電界発光素子。

【化7】

一般式 (9) :

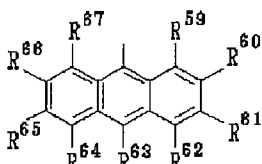


(但し、前記一般式 (9) において、R<sup>50</sup>、R<sup>51</sup>、R<sup>52</sup>、R<sup>53</sup>、R<sup>54</sup>、R<sup>55</sup>、R<sup>56</sup>、R<sup>57</sup>及びR<sup>58</sup>は互いに同一の又は異なる基であって、水素原子、或いはそれらの少なくとも1つがシアノ基、ニトロ基又はハロゲン原子である。)

【請求項7】 前記一般式 (1) におけるXが下記一般式 (10) で表される、請求項1に記載した有機電界発光素子。

【化8】

一般式 (10) :

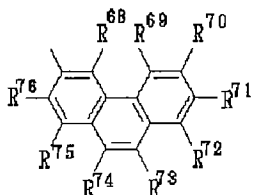


(但し、前記一般式 (10) において、R<sup>59</sup>、R<sup>60</sup>、R<sup>61</sup>、R<sup>62</sup>、R<sup>63</sup>、R<sup>64</sup>、R<sup>65</sup>、R<sup>66</sup>及びR<sup>67</sup>は互いに同一の又は異なる基であって、水素原子、或いはそれらの少なくとも1つがシアノ基、ニトロ基又はハロゲン原子である。)

【請求項8】 前記一般式 (1) におけるXが下記一般式 (11) で表される、請求項1に記載した有機電界発光素子。

【化9】

一般式 (11) :

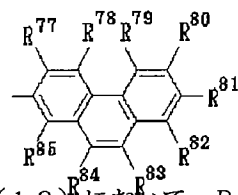


(但し、前記一般式 (11) において、R<sup>68</sup>、R<sup>69</sup>、R<sup>70</sup>、R<sup>71</sup>、R<sup>72</sup>、R<sup>73</sup>、R<sup>74</sup>、R<sup>75</sup>及びR<sup>76</sup>は互いに同一の又は異なる基であって、水素原子、或いはそれらの少なくとも1つがシアノ基、ニトロ基又はハロゲン原子である。)

【請求項9】 前記一般式 (1) におけるXが下記一般式 (12) で表される、請求項1に記載した有機電界発光素子。

【化10】

一般式 (12) :

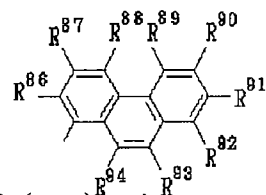


(但し、前記一般式 (12) において、R<sup>77</sup>、R<sup>78</sup>、R<sup>79</sup>、R<sup>80</sup>、R<sup>81</sup>、R<sup>82</sup>、R<sup>83</sup>、R<sup>84</sup>及びR<sup>85</sup>は互いに同一の又は異なる基であって、水素原子、或いはそれらの少なくとも1つがシアノ基、ニトロ基又はハロゲン原子である。)

【請求項10】 前記一般式 (1) におけるXが下記一般式 (13) で表される、請求項1に記載した有機電界発光素子。

【化11】

一般式 (13) :

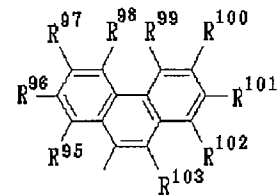


(但し、前記一般式 (13) において、R<sup>86</sup>、R<sup>87</sup>、R<sup>88</sup>、R<sup>89</sup>、R<sup>90</sup>、R<sup>91</sup>、R<sup>92</sup>、R<sup>93</sup>及びR<sup>94</sup>は互いに同一の又は異なる基であって、水素原子、或いはそれらの少なくとも1つがシアノ基、ニトロ基又はハロゲン原子である。)

【請求項11】 前記一般式 (1) におけるXが下記一般式 (14) で表される、請求項1に記載した有機電界発光素子。

【化12】

一般式 (14) :

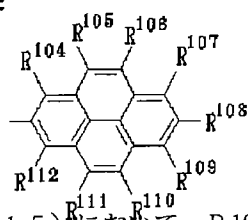


(但し、前記一般式 (14) において、R<sup>95</sup>、R<sup>96</sup>、R<sup>97</sup>、R<sup>98</sup>、R<sup>99</sup>、R<sup>100</sup>、R<sup>101</sup>、R<sup>102</sup>及びR<sup>103</sup>は互いに同一の又は異なる基であって、水素原子、或いはそれらの少なくとも1つがシアノ基、ニトロ基又はハロゲン原子である。)

【請求項12】 前記一般式 (1) におけるXが下記一般式 (15) で表される、請求項1に記載した有機電界発光素子。

【化13】

一般式 (15) :

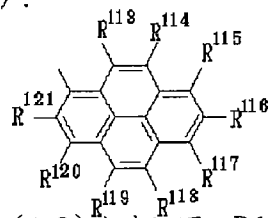


(但し、前記一般式 (15) において、 $R^{104}$ 、 $R^{105}$ 、 $R^{106}$ 、 $R^{107}$ 、 $R^{108}$ 、 $R^{109}$ 、 $R^{110}$ 、 $R^{111}$  及び  $R^{112}$  は互いに同一の又は異なる基であって、水素原子、或いはそれらの少なくとも1つがシアノ基、ニトロ基又はハロゲン原子である。)

【請求項13】 前記一般式 (1) におけるXが下記一般式 (16) で表される、請求項1に記載した有機電界発光素子。

【化14】

一般式 (16) :

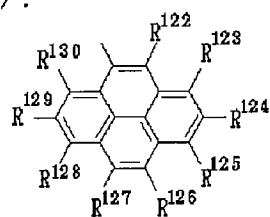


(但し、前記一般式 (16) において、 $R^{113}$ 、 $R^{114}$ 、 $R^{115}$ 、 $R^{116}$ 、 $R^{117}$ 、 $R^{118}$ 、 $R^{119}$ 、 $R^{120}$  及び  $R^{121}$  は互いに同一の又は異なる基であって、水素原子、或いはそれらの少なくとも1つがシアノ基、ニトロ基又はハロゲン原子である。)

【請求項14】 前記一般式 (1) におけるXが下記一般式 (17) で表される、請求項1に記載した有機電界発光素子。

【化15】

一般式 (17) :

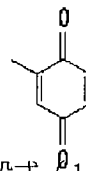


(但し、前記一般式 (17) において、 $R^{122}$ 、 $R^{123}$ 、 $R^{124}$ 、 $R^{125}$ 、 $R^{126}$ 、 $R^{127}$ 、 $R^{128}$ 、 $R^{129}$  及び  $R^{130}$  は互いに同一の又は異なる基であって、水素原子、或いはそれらの少なくとも1つがシアノ基、ニトロ基又はハロゲン原子である。)

【請求項15】 前記一般式 (1) におけるXが下記構造式 (18) で表される、請求項1に記載した有機電界発光素子。

【化16】

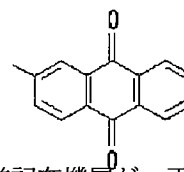
構造式 (18) :



【請求項16】 前記一般式 (1) におけるXが下記構造式 (19) で表される、請求項1に記載した有機電界発光素子。

【化17】

構造式 (19) :



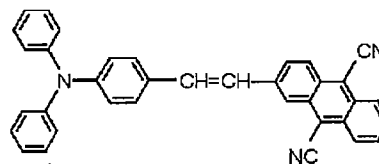
【請求項17】 前記有機層が、正孔輸送層と電子輸送層とが積層された有機積層構造を有しており、前記正孔輸送層の形成材料として前記スチリル化合物が用いられている、請求項1に記載した有機電界発光素子。

【請求項18】 前記有機層が、正孔輸送層と電子輸送層とが順次積層された有機積層構造を有しており、前記電子輸送層の形成材料として前記スチリル化合物が用いられている、請求項1に記載した有機電界発光素子。

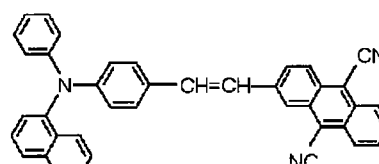
【請求項19】 前記有機層が、正孔輸送層と発光層と電子輸送層とが積層された有機積層構造を有しており、前記発光層の形成材料として前記スチリル化合物が用いられている、請求項1に記載した有機電界発光素子。

【請求項20】 発光領域を有する有機層が陽極と陰極との間に設けられている有機電界発光素子において、前記有機層に下記構造式 (20) - 1、(20) - 2、(20) - 3、(20) - 4、(20) - 5、(20) - 6、(20) - 7、(20) - 8、(20) - 9、(20) - 10、(20) - 11、(20) - 12、(20) - 13、(20) - 14、(20) - 15、(20) - 16、(20) - 17又は(20) - 18で表されるスチリル化合物の少なくとも1種が有機発光材料として含まれていることを特徴とする、有機電界発光素子。

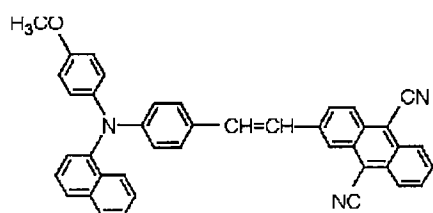
【化18】 構造式 (20) - 1 :



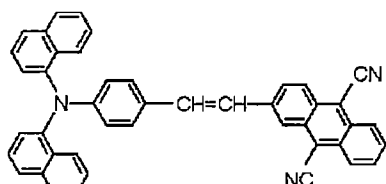
構造式 (20) - 2 :



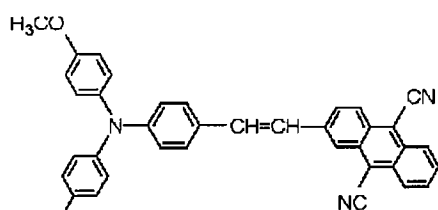
構造式(20)-3:



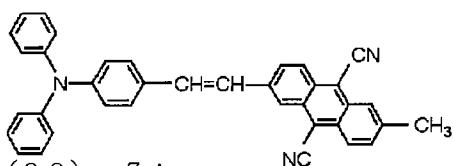
構造式(20)-4:



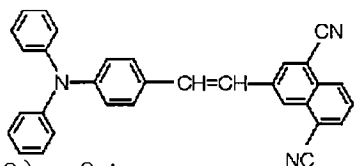
構造式(20)-5:



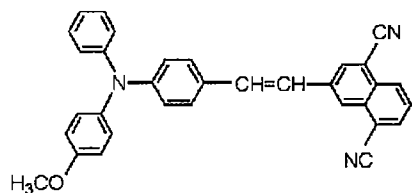
構造式(20)-6:



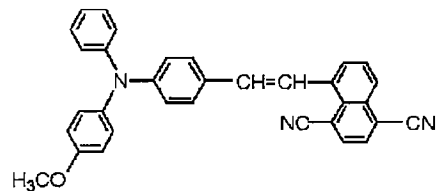
構造式(20)-7:



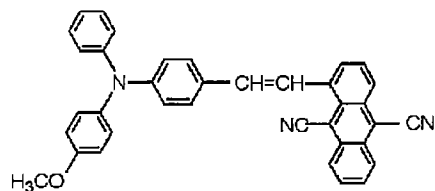
構造式(20)-8:



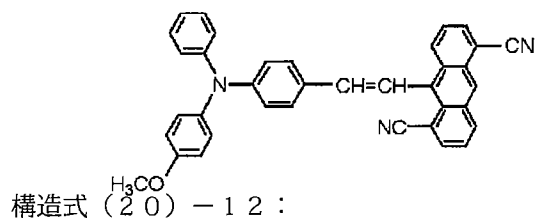
構造式(20)-9:



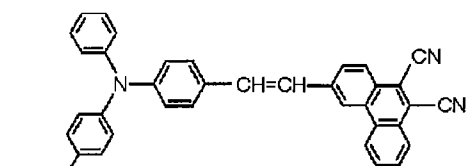
構造式(20)-10:



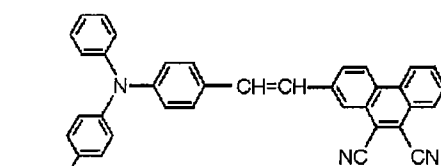
構造式(20)-11:



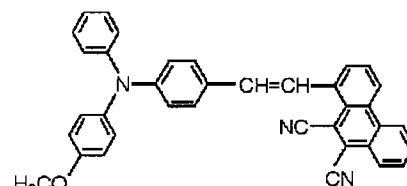
構造式(20)-12:



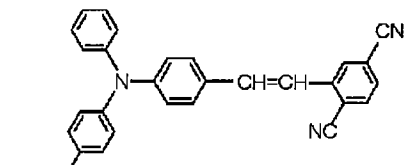
構造式(20)-13:



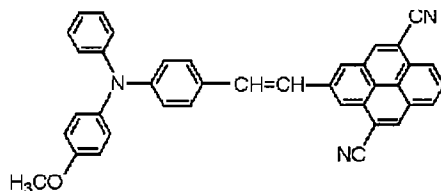
構造式(20)-14:



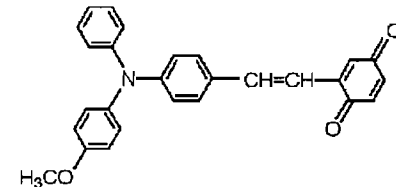
構造式(20)-15:



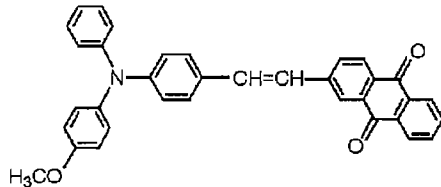
構造式(20)-16:



構造式(20)-17:



構造式(20)-18:



【請求項21】 前記有機層が、正孔輸送層と電子輸送層とが積層された有機積層構造を有しており、前記正孔

ている、請求項 20 に記載した有機電界発光素子。

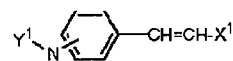
【請求項 22】 前記有機層が、正孔輸送層と電子輸送層とが順次積層された有機積層構造を有しており、前記電子輸送層の形成材料として前記スチリル化合物が用いられている、請求項 20 に記載した有機電界発光素子。

【請求項 23】 前記有機層が、正孔輸送層と発光層と電子輸送層とが積層された有機積層構造を有しており、前記発光層の形成材料として前記スチリル化合物が用いられている、請求項 20 に記載した有機電界発光素子。

【請求項 24】 発光領域を有する有機層が陽極と陰極との間に設けられている有機電界発光素子において、前

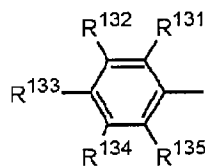
記有機層のうちの少なくとも 1 層が下記一般式 [I] で示されるアミノスチリル化合物で構成され、かつ前記アミノスチリル化合物で構成された有機層の陰極側に接してホールブロッキング層が存在することを特徴とする、有機電界発光素子。

【化 19】 一般式 [I] :

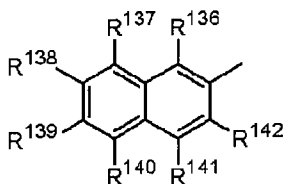


[但し、前記一般式 [I] において、X¹ は下記一般式 (21) ~ (33) で表される基であり、

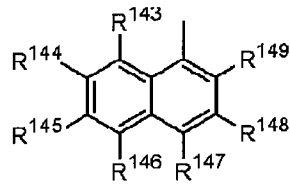
【化 20】



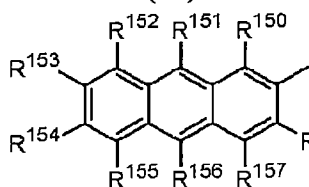
(21)



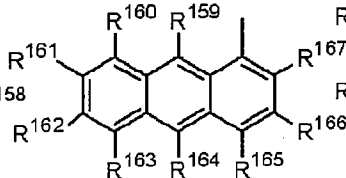
(22)



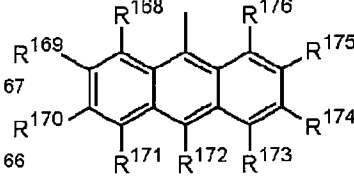
(23)



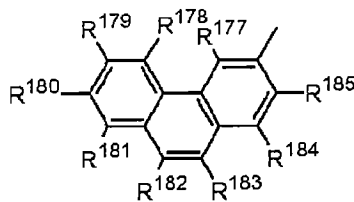
(24)



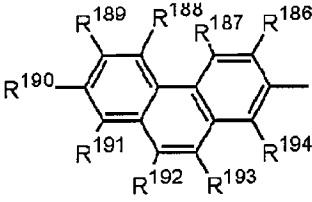
(25)



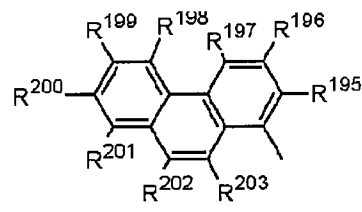
(26)



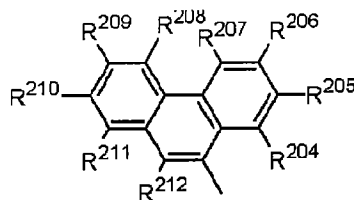
(27)



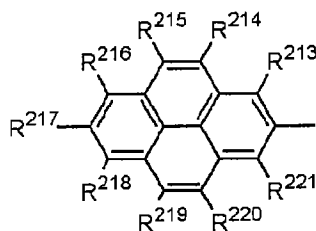
(28)



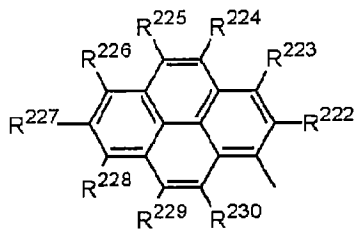
(29)



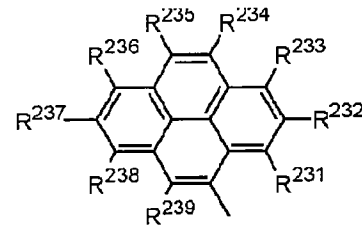
(30)



(31)



(32)

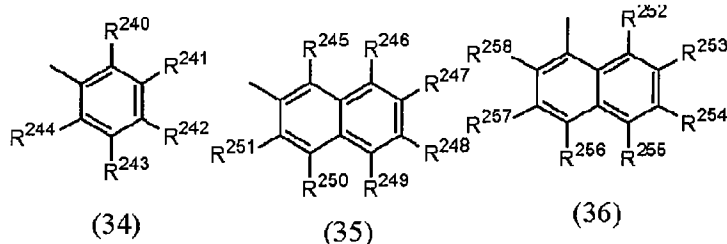


(33)

(但し、前記一般式 (21) ~ (33) において、R¹³¹ ~ R²³⁹ は水素原子、またはハロゲン原子、ニトロ基、シアノ基、トリフルオロメチル基から選ばれた基であり、それらが同一であっても異なっても良い。)

ル基、または下記一般式 (34) ~ (36) で表される置換基を有しても良いアリール基から選ばれた基であり、それらが同一であっても異なっても良い。

【化 21】



(但し、前記一般式(34)～(36)において、 $R^{240}$ ～ $R^{258}$ は水素原子、置換基を有しても良いアルキル基、置換基を有しても良いアリール基、置換基を有しても良いアルコキシ基、ハロゲン原子、ニトロ基、シアノ基、トリフルオロメチル基から選ばれた基であって、それらが同一であっても異なっても良い。)

【請求項25】 前記有機層が、ホール輸送層と電子輸送層とが積層された有機積層構造をしており、前記有機層のうちの少なくとも電子輸送層が前記一般式[I]で示されるアミノスチリル化合物で構成され、かつ前記アミノスチリル化合物で構成された層の陰極側に接して前記ホールブロッキング層が存在する請求項24に記載した有機電界発光素子。

【請求項26】 前記有機層が、ホール輸送層と電子輸送層とが積層された有機積層構造をしており、前記有機層のうちの少なくともホール輸送層が前記一般式[I]で示されるアミノスチリル化合物で構成され、かつ前記アミノスチリル化合物で構成された層の陰極側に接して前記ホールブロッキング層が存在する、請求項24に記載した有機電界発光素子。

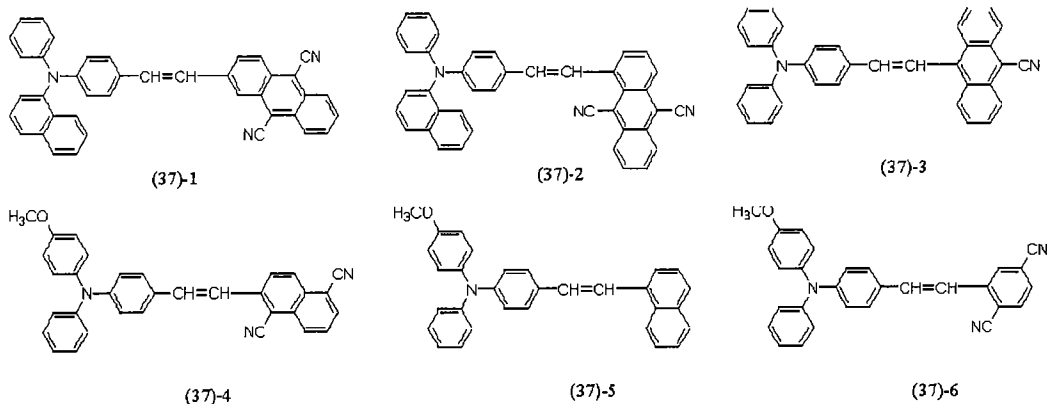
【請求項27】 前記有機層が、ホール輸送層と電子輸送層とが積層された有機積層構造をしており、前記ホー

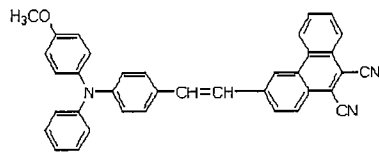
ル輸送層が前記一般式[I]で示されるアミノスチリル化合物で構成され、かつ前記電子輸送層が前記一般式[I]で示されるアミノスチリル化合物で構成され、かつこの電子輸送性発光性層の陰極側に接して前記ホールブロッキング層が存在する、請求項24に記載した有機電界発光素子。

【請求項28】 前記有機層が、ホール輸送層と発光層と電子輸送層とが積層された有機積層構造をしており、前記有機層のうちの少なくとも前記発光層が前記一般式[I]で示されるアミノスチリル化合物で構成され、かつ前記アミノスチリル化合物で構成された層の陰極側に接して前記ホールブロッキング層が存在する、請求項24に記載した有機電界発光素子。

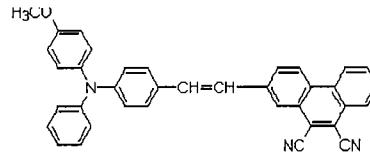
【請求項29】 発光領域を有する有機層が陽極と陰極との間に設けられている有機電界発光素子において、前記有機層のうちの少なくとも1層が下記構造式(37)～(37)‑13で示されるアミノスチリル化合物で構成され、かつ前記アミノスチリル化合物で構成された層の陰極側に接してホールブロッキング層が存在することを特徴とする、有機電界発光素子。

【化22】

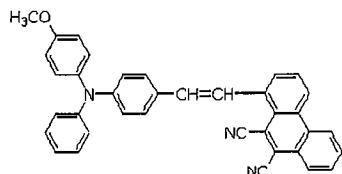




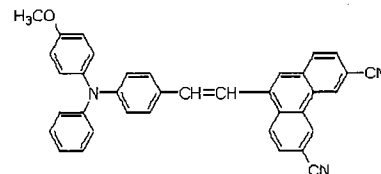
(37)-7



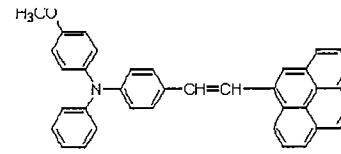
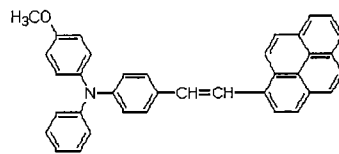
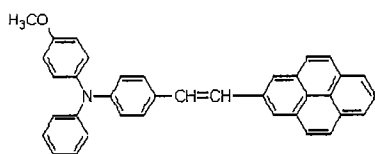
(37)-8



(37)-9



(37)-10



【請求項 30】 前記有機層が、ホール輸送層と電子輸送層とが積層された有機積層構造をしており、前記有機層のうちの少なくとも電子輸送層が前記構造式(37)－1～(37)－13で示されるアミノスチリル化合物で構成され、かつ前記アミノスチリル化合物で構成された層に接して陰極側に前記ホールブロッキング層が存在する、請求項 29に記載した有機電界発光素子。

【請求項 31】 前記有機層が、ホール輸送層と電子輸送層とが積層された有機積層構造をしており、前記有機層のうちの少なくともホール輸送層が前記構造式(37)－1～(37)－13で示されるアミノスチリル化合物で構成され、かつ前記アミノスチリル化合物で構成された層に接して陰極側に前記ホールブロッキング層が存在する、請求項 29に記載した有機電界発光素子。

【請求項 32】 前記有機層が、ホール輸送層と電子輸送層とが積層された有機積層構造をしており、前記ホール輸送層が前記構造式(37)－1～(37)－13で示されるアミノスチリル化合物で構成され、かつ前記電子輸送層が前記構造式(37)－1～(37)－13で示されるアミノスチリル化合物で構成され、かつ前記電子輸送性発光層の陰極側に接して前記ホールブロッキング層が存在する、請求項 29に記載した有機電界発光素子。

【請求項 33】 前記有機層が、ホール輸送層と発光層と電子輸送層とが積層された有機積層構造をしており、前記有機層のうちの少なくとも前記発光層が前記構造式(37)－1～(37)－13で示されるアミノスチリル化合物で構成され、かつ前記アミノスチリル化合物で構成された層の陰極側に接して前記ホールブロッキング層が存在する、請求項 29に記載した有機電界発光素子。

【発明の詳細な説明】

【発明の属する技術分野】本発明は、発光領域を有する有機層が陽極と陰極との間に設けられている有機電界発光素子(有機EL素子)に関するものである。

【0002】

【従来の技術】軽量で高効率のフラットパネルディスプレイが、例えばコンピュータやテレビジョンの画面表示用として盛んに研究、開発されている。

【0003】まず、ブラウン管(CRT)は、輝度が高く、色再現性が良いため、現在ディスプレイとして最も多く使われているが、嵩高く、重く、また消費電力も高いという問題がある。

【0004】また、軽量で高効率のフラットパネルディスプレイとして、アクティブマトリクス駆動などの液晶ディスプレイが商品化されている。しかしながら、液晶ディスプレイは、視野角が狭く、また、自発光でないため周囲が暗い環境下ではバックライトの消費電力が大きいことや、今後実用化が期待されている高精細度の高速ビデオ信号に対して十分な応答性能を有しない等の問題点がある。特に、大画面サイズのディスプレイを製造することは困難であり、そのコストが高い等の課題もある。

【0005】これに対する代替として、発光ダイオードを用いたディスプレイの可能性はあるが、やはり製造コストが高く、また、1つの基板上に発光ダイオードのマトリクス構造を形成することが難しい等の問題があり、ブラウン管に取って代わる低価格のディスプレイ候補としては、実用化までの課題が大きい。

【0006】これらの諸課題を解決する可能性のあるフラットパネルディスプレイとして、最近、有機発光材料を用いた有機電界発光素子(有機EL素子)が注目されている。即ち、発光材料として有機化合物を用いることにより、自発光で、応答速度が高速であり、視野角依存



ている。

【0007】有機電界発光素子の構成は、透光性の正極と金属陰極との間に、電流の注入によって発光する発光材料を含む有機薄膜を形成したものである。C. W. Tang, S. A. VanSlyke等は Applied Physics Letters第51巻12号913～915頁(1987年)掲載の研究報告において、有機薄膜を正孔輸送性材料からなる薄膜と電子輸送性材料からなる薄膜との2層構造として、各々の電極から有機膜中に注入されたホールと電子が再結合することにより発光する素子構造を開発した(シングルヘテロ構造の有機EL素子)。

【0008】この素子構造では、正孔輸送材料または電子輸送材料のいずれかが発光材料を兼ねており、発光は発光材料の基底状態と励起状態のエネルギーギャップに対応した波長帯で起きる。このような2層構造とすることにより、大幅な駆動電圧の低減、発光効率の改善が行われた。

【0009】その後、C. Adachi、S. Tokita、T. Tsutsui、S. Saito等の Japanese Journal of Applied Physics第27巻2号L269～L271頁(1988年)掲載の研究報告に記載されているように、正孔輸送材料、発光材料、電子輸送材料の3層構造(ダブルヘテロ構造の有機EL素子)が開発され、更に、C. W. Tang、S. A. VanSlyke、C. H. Chen等の Journal of Applied Physics 第65巻9号3610～3616頁(1989年)掲載の研究報告に記載されているように、電子輸送材料中に発光材料を含ませた素子構造などが開発された。これらの研究により、低電圧で、高輝度の発光の可能性が検証され、近年、研究開発が非常に活発に行われている。

【0010】発光材料に用いる有機化合物は、その多様性から、理論的には分子構造を変化させることによって発光色を任意に変えることができるという利点があると言える。従って、分子設計を施すことにより、フルカラーディスプレイに必要な色純度の良いR(赤)、G(緑)、B(青)の3色を揃えることは、無機物を用いた薄膜EL素子と比べて容易であると言える。

【0011】

【発明が解決しようとする課題】しかしながら、実際には有機電界発光素子においても、解決しなければならない問題がある。安定した高輝度の赤色発光素子の開発は難しく、現在報告されている電子輸送材料として、トリス(8-キノリノール)アルミニウム(以下、Alq<sub>3</sub>と略称。)にDCM[4-ジシアノメチレン-6-(p-ジメチルアミノスチリル)-2-メチル-4H-ピラン]をドーブした赤色発光の例(Chem.Funct.Dyes,Proc.Int.Symp.,2nd P.536(1993)等)においても、最高輝度、信頼性ともにディスプレイ材料としては満足の行くものではない。

d Organic electroluminescence 会議(1996、Berlin)で報告したBSB-BCNは、1000cd/m<sup>2</sup>以上の高い輝度を実現しているが、フルカラーに対応する赤色としての色度が完全なものとは言えない。

【0013】さらに高輝度で安定かつ色純度の高い赤色発光素子の実現が、望まれているのが現状である。

【0014】また、特開平7-188649号(特願平6-148798号)においては、特定のジスチリル化合物を有機電界発光材料とすることを提案しているが、目的の発光色が青色であり、赤色用ではない。一方、有機電界発光素子の積層構造の中にホールと電子のエネルギー的な閉じ込め構造を作ることによって発光層にてホールと電子が効率良く結合し、高い輝度および発光材料独自の純粋な発光を得られることが報告されている(特開平10-79297、特開平11-204258、特開平11-204264、特開平11-204259等)が、目的の発光色はやはり青色であり、赤色用ではない。

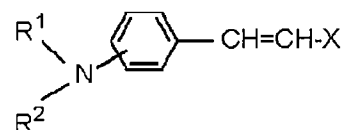
【0015】本発明の目的は、高輝度かつ安定な赤色発光を有する有機電界発光素子を提供することにある。本発明の第二の目的は、本来高い量子収率を有する本発明の化合物を含有する有機電界発光素子において発光層でのホールと電子の再結合を促進し、さらに高輝度かつ高効率な発光を呈する有機電界発光素子を提供することにある。

【0016】

【課題を解決するための手段】本発明は上記課題を解決するために鋭意検討した結果、発光材料として特定のスチリル化合物を用いることによって、安定した、高輝度のフルカラーディスプレイ実現に極めて有用な信頼性の高い赤色発光素子を提供できることを見出し、本発明に到達したものである。

【0017】即ち、本発明は、発光領域を有する有機層が陽極と陰極との間に設けられ、電流の注入によって発光する有機物質を構成要素として含む有機電界発光素子において、前記有機層に下記一般式(1)で表される非対称構造のスチリル化合物の少なくとも1種が有機発光材料として含まれていることを特徴とする、有機電界発光素子に係るものである。

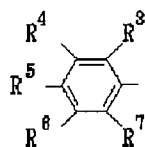
【化23】一般式(1)：



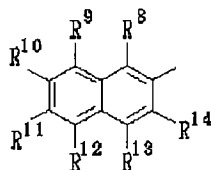
【但し、前記一般式(1)において、R<sup>1</sup>及びR<sup>2</sup>は互いに同一の又は異なる基であって、下記一般式(2)、(3)又は(4)で表されるアリール基であり

【化24】

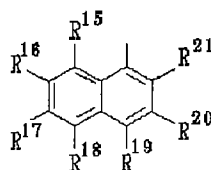
一般式(2) :



一般式(3) :



一般式(4) :



(但し、前記一般式(2)、(3)及び(4)において、 $R^3$ 、 $R^4$ 、 $R^5$ 、 $R^6$ 、 $R^7$ 、 $R^8$ 、 $R^9$ 、 $R^{10}$ 、 $R^{11}$ 、 $R^{12}$ 、 $R^{13}$ 、 $R^{14}$ 、 $R^{15}$ 、 $R^{16}$ 、 $R^{17}$ 、 $R^{18}$ 、 $R^{19}$ 、 $R^{20}$ 及び $R^{21}$ は互いに同一の又は異なる基であって、水素原子、或いはそれらの少なくとも1つが飽和又は不飽和アルコキシル基(炭素数が好ましくは1~24、更には1~10のもの)、アルキル基(炭素数が好ましくは1~24、更には1~10のもの)、アミノ基、アルキルアミノ基(炭素数が好ましくは1~24、更には1~10のもの)又はアリール基である。)、Xは置換又は無置換のアリール基又は炭化水素環基である。]

【0018】上記一般式(1)のスチリル化合物を発光材料に用いることによって、高輝度で安定な赤色発光が得られると共に、電気的、熱的或いは化学的にも安定性に優れた素子を提供できる。上記一般式(1)で表されるスチリル化合物はそれぞれ単独で用いることができるが、併用してもよい。

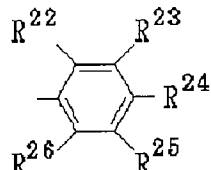
【0019】

【発明の実施の形態】本発明に用いる上記一般式(1)のスチリル化合物において、上記のXとしては下記一般式(5)~(17)、構造式(18)~(19)で表される基であることが望ましい。

【0020】

【化25】

一般式(5) :



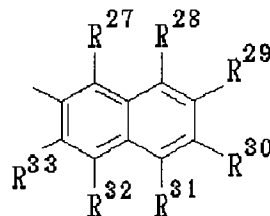
(但し、前記一般式(5)において、 $R^{22}$ 、 $R^{23}$ 、

て、それらの少なくとも1つがシアノ基、ニトロ基又はF、Cl、Br、I等の(以下、同様)ハロゲン原子である。)

【0021】

【化26】

一般式(6) :

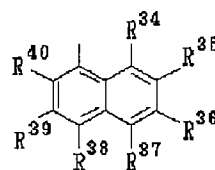


(但し、前記一般式(6)において、 $R^{27}$ 、 $R^{28}$ 、 $R^{29}$ 、 $R^{30}$ 、 $R^{31}$ 、 $R^{32}$ 及び $R^{33}$ は互いに同一の又は異なる基であって、水素原子、或いはそれらの少なくとも1つがシアノ基、ニトロ基又はハロゲン原子である。)

【0022】

【化27】

一般式(7) :

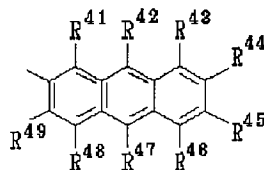


(但し、前記一般式(7)において、 $R^{34}$ 、 $R^{35}$ 、 $R^{36}$ 、 $R^{37}$ 、 $R^{38}$ 、 $R^{39}$ 及び $R^{40}$ は互いに同一の又は異なる基であって、水素原子、或いはそれらの少なくとも1つがシアノ基、ニトロ基又はハロゲン原子である。)

【0023】

【化28】

一般式(8) :

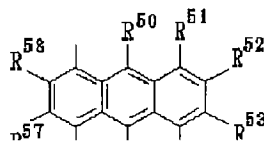


(但し、前記一般式(8)において、 $R^{41}$ 、 $R^{42}$ 、 $R^{43}$ 、 $R^{44}$ 、 $R^{45}$ 、 $R^{46}$ 、 $R^{47}$ 、 $R^{48}$ 及び $R^{49}$ は互いに同一の又は異なる基であって、水素原子、或いはそれらの少なくとも1つがシアノ基、ニトロ基又はハロゲン原子である。)

【0024】

【化29】

一般式(9) :

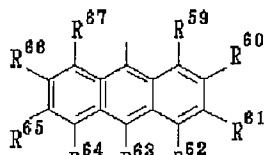


(但し、前記一般式(9)において、R<sup>50</sup>、R<sup>51</sup>、R<sup>52</sup>、R<sup>53</sup>、R<sup>54</sup>、R<sup>55</sup>、R<sup>56</sup>、R<sup>57</sup>及びR<sup>58</sup>は互いに同一の又は異なる基であって、水素原子、或いはそれらの少なくとも1つがシアノ基、ニトロ基又はハロゲン原子である。)

【0025】

【化30】

一般式(10)：

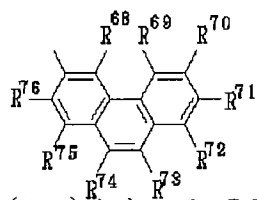


(但し、前記一般式(10)において、R<sup>59</sup>、R<sup>60</sup>、R<sup>61</sup>、R<sup>62</sup>、R<sup>63</sup>、R<sup>64</sup>、R<sup>65</sup>、R<sup>66</sup>及びR<sup>67</sup>は互いに同一の又は異なる基であって、水素原子、或いはそれらの少なくとも1つがシアノ基、ニトロ基又はハロゲン原子である。)

【0026】

【化31】

一般式(11)：

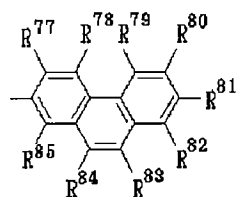


(但し、前記一般式(11)において、R<sup>68</sup>、R<sup>69</sup>、R<sup>70</sup>、R<sup>71</sup>、R<sup>72</sup>、R<sup>73</sup>、R<sup>74</sup>、R<sup>75</sup>及びR<sup>76</sup>は互いに同一の又は異なる基であって、水素原子、或いはそれらの少なくとも1つがシアノ基、ニトロ基又はハロゲン原子である。)

【0027】

【化32】

一般式(12)：

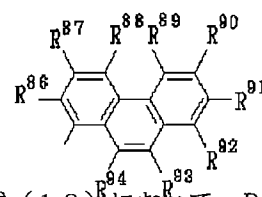


(但し、前記一般式(12)において、R<sup>77</sup>、R<sup>78</sup>、R<sup>79</sup>、R<sup>80</sup>、R<sup>81</sup>、R<sup>82</sup>、R<sup>83</sup>、R<sup>84</sup>及びR<sup>85</sup>は互いに同一の又は異なる基であって、水素原子、或いはそれらの少なくとも1つがシアノ基、ニトロ基又はハロゲン原子である。)

【0028】

【化33】

一般式(13)：

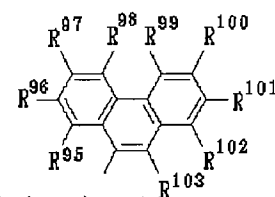


(但し、前記一般式(13)において、R<sup>86</sup>、R<sup>87</sup>、R<sup>88</sup>、R<sup>89</sup>、R<sup>90</sup>、R<sup>91</sup>、R<sup>92</sup>、R<sup>93</sup>及びR<sup>94</sup>は互いに同一の又は異なる基であって、水素原子、或いはそれらの少なくとも1つがシアノ基、ニトロ基又はハロゲン原子である。)

【0029】

【化34】

一般式(14)：

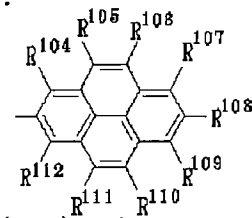


(但し、前記一般式(14)において、R<sup>95</sup>、R<sup>96</sup>、R<sup>97</sup>、R<sup>98</sup>、R<sup>99</sup>、R<sup>100</sup>、R<sup>101</sup>、R<sup>102</sup>及びR<sup>103</sup>は互いに同一の又は異なる基であって、水素原子、或いはそれらの少なくとも1つがシアノ基、ニトロ基又はハロゲン原子である。)

【0030】

【化35】

一般式(15)：

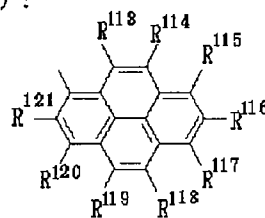


(但し、前記一般式(15)において、R<sup>104</sup>、R<sup>105</sup>、R<sup>106</sup>、R<sup>107</sup>、R<sup>108</sup>、R<sup>109</sup>、R<sup>110</sup>、R<sup>111</sup>及びR<sup>112</sup>は互いに同一の又は異なる基であって、水素原子、或いはそれらの少なくとも1つがシアノ基、ニトロ基又はハロゲン原子である。)

【0031】

【化36】

一般式(16)：

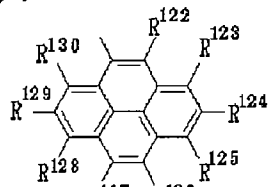


(但し、前記一般式(16)において、R<sup>113</sup>、R<sup>114</sup>、R<sup>115</sup>、R<sup>116</sup>、R<sup>117</sup>、R<sup>118</sup>、R<sup>119</sup>、R<sup>120</sup>及びR<sup>121</sup>は互いに同一の又は異なる基であって、水素原子、或いはそれらの少なくとも1つがシアノ基、

【0032】

【化37】

一般式 (17) :

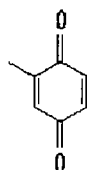


(但し、前記一般式 (17) において、R<sup>122</sup>、R<sup>123</sup>、R<sup>124</sup>、R<sup>125</sup>、R<sup>126</sup>、R<sup>127</sup>、R<sup>128</sup>、R<sup>129</sup> 及び R<sup>130</sup> は互いに同一の又は異なる基であって、水素原子、或いはそれらの少なくとも1つがシアノ基、ニトロ基又はハロゲン原子である。)

【0033】

【化38】

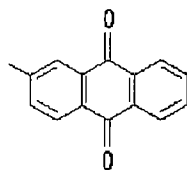
構造式 (18) :



【0034】

【化39】

構造式 (19) :

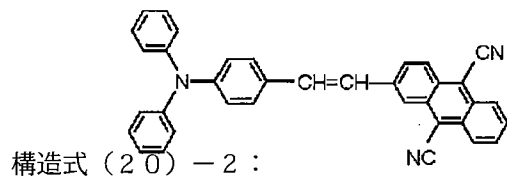


【0035】これらのXは、本発明に用いる発光材料が赤色発光を生じる上で重要であるが、例えばベンゼン環の数が増えるに従って、有機発光材料の発光波長は長波長側にシフトする傾向がある。また、上記構造式 (18) 及び (19) のXについても、他の一般式のものと同様、発光材料の発光は赤色発光である。

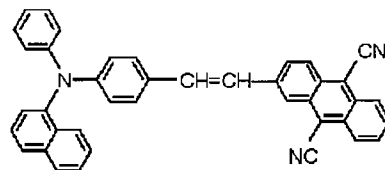
【0036】本発明の有機電界発光素子において、発光材料である一般式 (1) で示されるスチリル化合物は、例えば下記構造式 (20) - 1、(20) - 2、(20) - 3、(20) - 4、(20) - 5、(20) - 6、(20) - 7、(20) - 8、(20) - 9、(20) - 10、(20) - 11、(20) - 12、(20) - 13、(20) - 14、(20) - 15、(20) - 16、(20) - 17又は(20) - 18のような分子構造の少なくとも1種が使用可能である。これらはいずれも、4-ジアリルアミノスチリル系化合物である。

【0037】

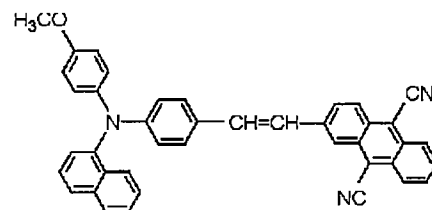
【化40】構造式 (20) - 1 :



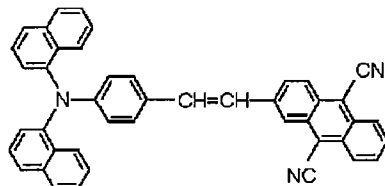
構造式 (20) - 2 :



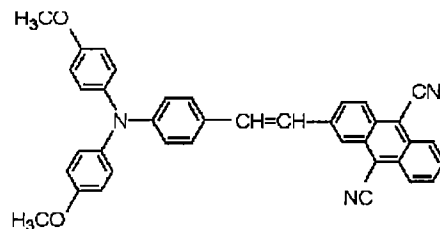
構造式 (20) - 3 :



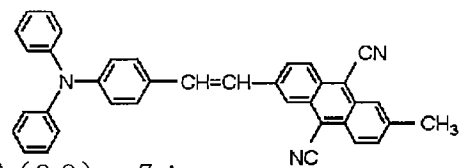
構造式 (20) - 4 :



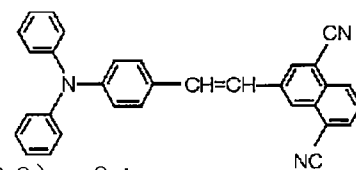
構造式 (20) - 5 :



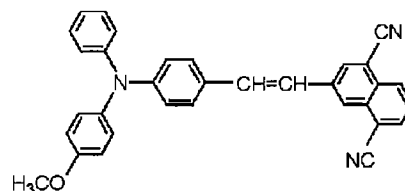
構造式 (20) - 6 :



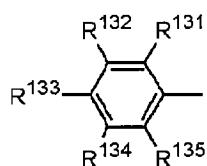
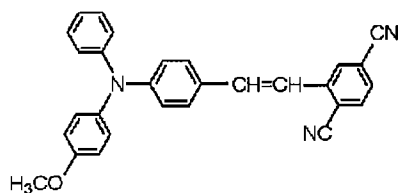
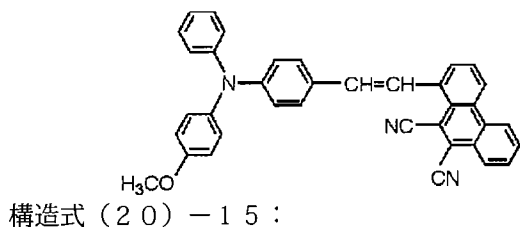
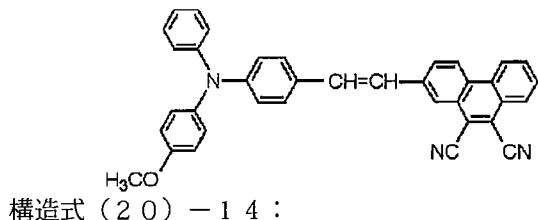
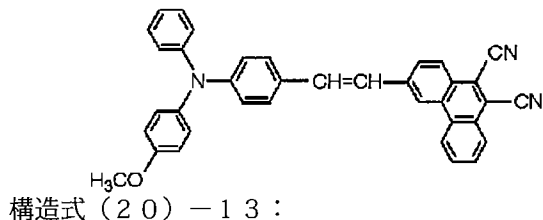
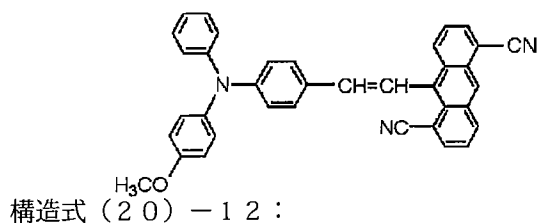
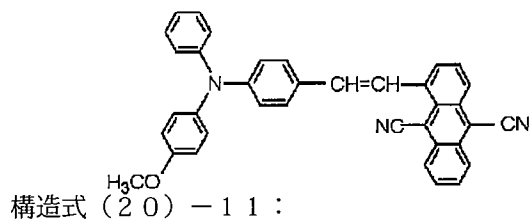
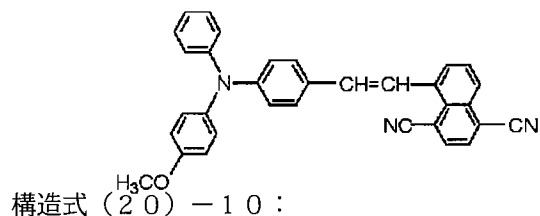
構造式 (20) - 7 :



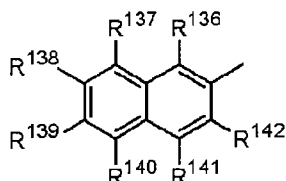
構造式 (20) - 8 :



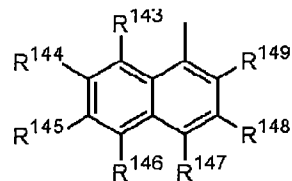
構造式 (20) - 9 :



(21)

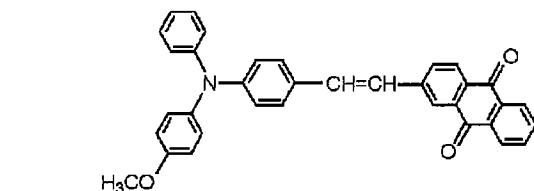
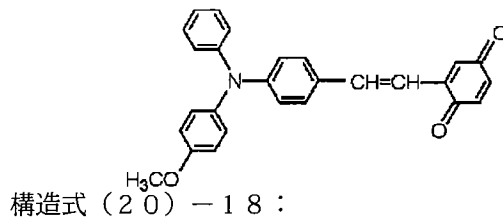
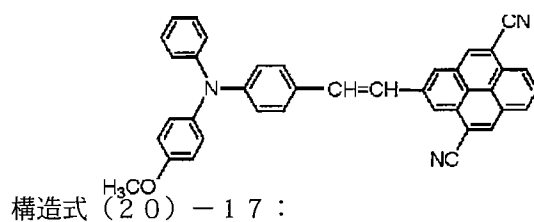


(22)



(23)

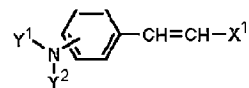
構造式 (20) - 16 :



【0038】本発明者はまた、上記課題を解決するために鋭意検討した結果、特定のスチリル化合物と、それに効率良くエネルギーを伝達することが可能な材料とから発光層を構成した有機電界発光素子を作製し、さらに高輝度、高信頼性の赤色発光素子を提供する本発明に到達したものである。

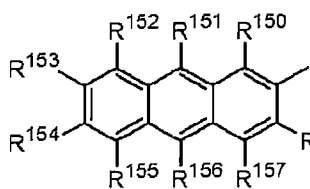
【0039】即ち本発明は、発光領域を有する有機層が陽極と陰極との間に設けられ、電流の注入によって発光する有機物質を構成要素として含む有機電界発光素子において、前記有機層のうちの少なくとも1層が下記一般式〔I〕で示されるアミノスチリル化合物からなる層であることを特徴とする有機電界発光素子に係るものである。

【化41】一般式〔I〕：

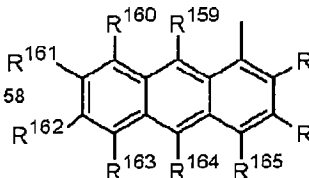


〔但し、前記一般式〔I〕において、X<sup>1</sup>は下記一般式(21)～(23)で表される基であり、

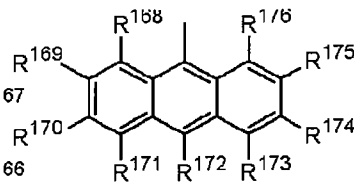
【化42】



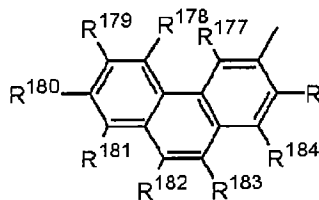
(24)



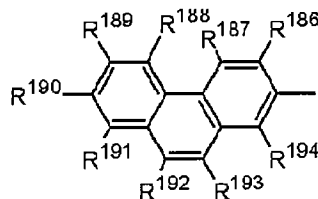
(25)



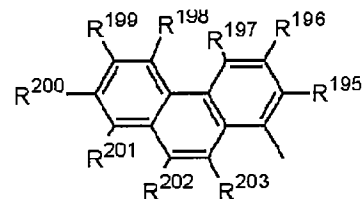
(26)



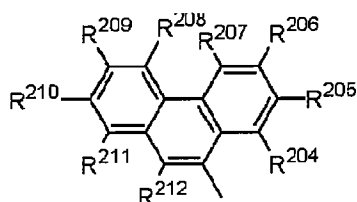
(27)



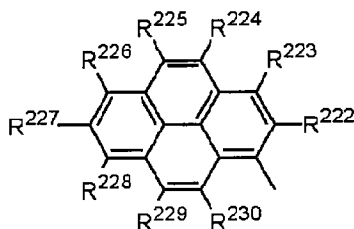
(28)



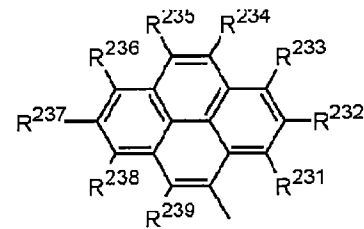
(29)



(30)



(31)



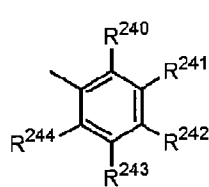
(32)

(但し、前記一般式(21)～(33)において、R<sup>131</sup>～R<sup>239</sup>は水素原子、またはハロゲン原子、ニトロ基、シアノ基、トリフルオロメチル基から選ばれた基であり、それらが同一であっても異なっても良い。)

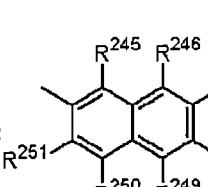
また、Y<sup>1</sup>、Y<sup>2</sup>は水素原子、置換基を有しても良いアルキ

ル基、または下記一般式(34)～(36)で表される置換基を有しても良いアリール基から選ばれた基であり、それらが同一であっても異なっても良い。

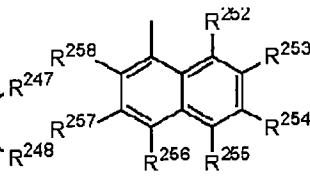
【化43】



(34)



(35)



(36)

(但し、前記一般式(34)～(36)において、R<sup>240</sup>～R<sup>258</sup>は水素原子、置換基を有しても良いアルキル基、置換基を有しても良いアリール基、置換基を有しても良いアルコキシ基、ハロゲン原子、ニトロ基、シアノ基、トリフルオロメチル基から選ばれた基であって、それらが同一であっても異なっても良い。)]

【0040】また本発明は、本来高い量子収率を有する上記の本発明の化合物を含有する有機電界発光素子において、発光層の陰極側にホール(正孔)ブロッキング層

効率良く行われ、発光材料独自の純粋な発光が高輝度かつ高効率に得られる有機電界発光素子を提供するに至ったものである。

【0041】即ち本発明はまた、発光領域を有する有機層が陽極と陰極との間に設けられている有機電界発光素子において、前記有機層の少なくとも1層が前記一般式[I]で示されるアミノスチリル化合物からなり、かつ前記アミノスチリル化合物を含む有機層の陰極側にホールブロッキング層が存在する有機電界発光素子に係るも

【0042】例えば、前記有機層が、ホール輸送層と電子輸送層とが積層された有機積層構造をしており、前記有機層のうちの少なくとも電子輸送層が前記一般式

〔I〕で示されるアミノスチリル化合物で構成され、かつ前記アミノスチリル化合物で構成された層の陰極側に接して前記ホール（正孔）ブロッキング層が存在してよい。

【0043】また、前記有機層が、ホール輸送層と電子輸送層とが積層された有機積層構造をしており、前記有機層のうちの少なくともホール輸送層が前記一般式

〔I〕で示されるアミノスチリル化合物で構成され、かつ前記アミノスチリル化合物で構成された層の陰極側に接して前記ホールブロッキング層が存在してよい。

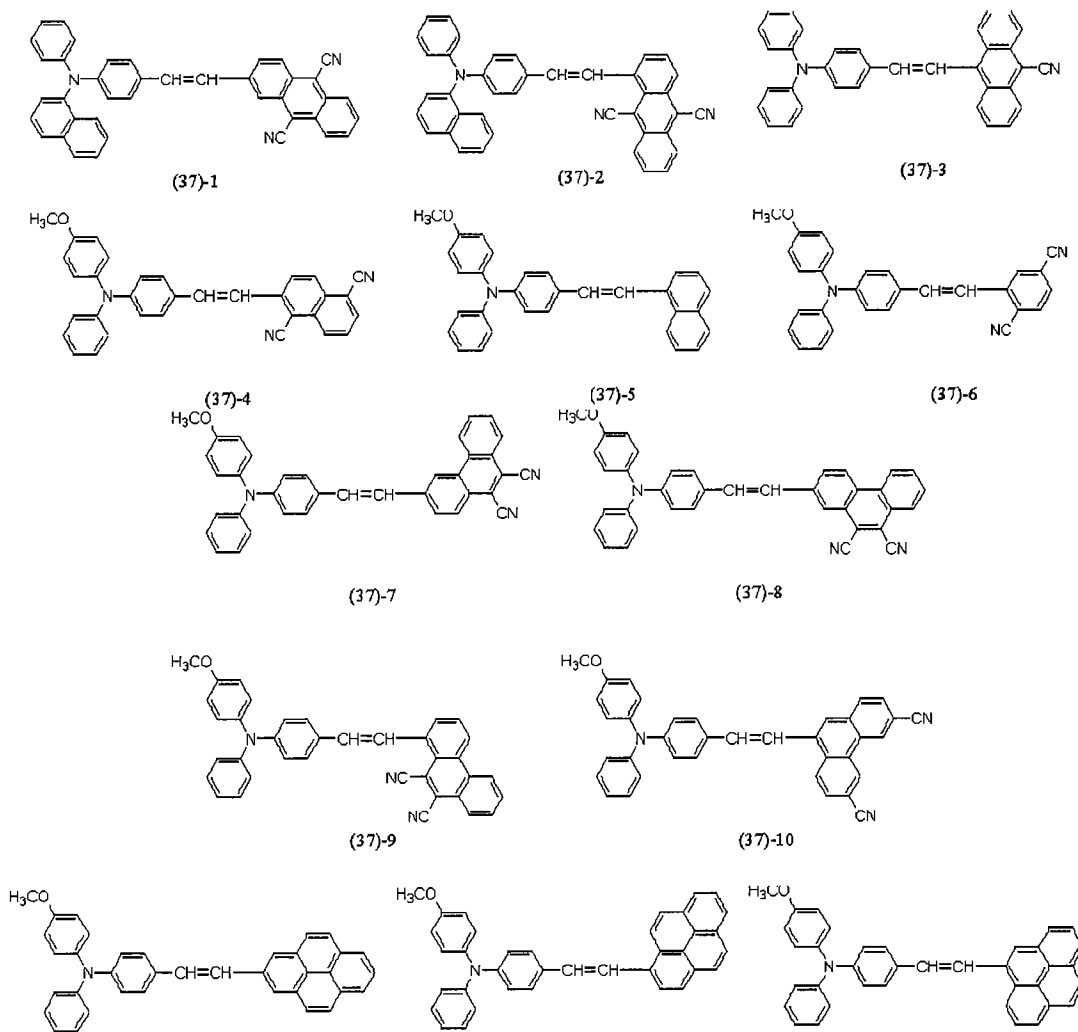
【0044】また、前記有機層が、ホール輸送層と電子輸送層とが積層された有機積層構造をしており、前記ホール輸送層が前記一般式〔I〕で示されるアミノスチリ

ル化合物で構成され、かつ前記電子輸送層が前記一般式〔I〕で示されるアミノスチリル化合物で構成され、かつこの電子輸送性発光性層の陰極側に接して前記ホールブロッキング層が存在してよい。

【0045】また、前記有機層が、ホール輸送層と発光層と電子輸送層とが積層された有機積層構造をしており、前記有機層のうちの少なくとも発光層が前記一般式〔I〕で示されるアミノスチリル化合物で構成され、かつ前記アミノスチリル化合物で構成された層の陰極側に接して前記ホールブロッキング層が存在してよい。

【0046】本発明の有機電界発光素子において、一般式〔I〕で示されるアミノスチリル化合物としては、下記構造式（37）-1～（37）-13のような分子構造の少なくとも一種が使用可能である。

【化44】



【0047】また、ホールブロッキング層に適した材料とは、次のようなエネルギー状態を有するものであることが望ましい。すなわち、ホールブロッキング層を形成する材料の最高占有分子軌道レベルが、ホールブロッキング層の陽極側に接する層を形成する材料の最高占有分子軌道レベルより低いエネルギーレベルにあること。な

有分子軌道レベルが、ホールブロッキング層の陽極側に接する層を形成する材料の最低非占有分子軌道レベルより高いエネルギーレベルにあり、またホールブロッキング層の陰極側に接する層を形成する材料の最低非占有分子軌道レベルより低いエネルギーレベルにあることである。

297、特開平11-204258、特開平11-204264、特開平11-204259等に示されたフェナントロリン誘導体が挙げられるが、上記のエネルギーレベルの条件を満たすものであれば、フェナントロリン誘導体に限定されるものではない。

【0049】図1～図4及び図5～図8は、本発明に基づく有機電界発光素子の例をそれぞれ示すものである。

【0050】図1は陰極3を発光光20が透過する透過型有機電界発光素子Aであって、発光20は保護層4の側からも観測できる。図2は陰極3での反射光も発光光20として得る反射型有機電界発光素子Bを示す。

【0051】図中、1は有機電界発光素子を形成するための基板であり、ガラス、プラスチック及び他の適宜の材料を用いることができる。また、有機電界発光素子を他の表示素子と組み合わせて用いる場合には、基板を共用することもできる。2は透明電極（陽極）であり、ITO（Indium tin oxide）、 $\text{SnO}_2$ 等を使用できる。

【0052】また、5は有機発光層であり、上記したスチリル化合物を発光材料として含有している。この発光層について、有機電界発光20を得る層構成としては、従来公知の種々の構成を用いることができる。後述するように、例えば、正孔輸送層と電子輸送層のいずれかを構成する材料が発光性を有する場合、これらの薄膜を積層した構造を使用できる。更に本発明の目的を満たす範囲で電荷輸送性能を上げるために、正孔輸送層と電子輸送層のいずれか若しくは両方が、複数種の材料の薄膜を積層した構造、または、複数種の材料を混合した組成からなる薄膜を使用するのを妨げない。また、発光性能を上げるために、少なくとも1種以上の蛍光性の材料を用いて、この薄膜を正孔輸送層と電子輸送層の間に挟持した構造、更に少なくとも1種以上の蛍光性の材料を正孔輸送層若しくは電子輸送層、またはこれらの両方に含ませた構造を使用しても良い。これらの場合には、発光効率を改善するために、正孔または電子の輸送を制御するための薄膜をその層構成に含ませることも可能である。

【0053】例えば上記の構造式（20）で例示したスチリル化合物は、電子輸送性能と正孔輸送性能の両方を持つため、素子構成中、電子輸送層を兼ねた発光層としても、或いは正孔輸送層を兼ねた発光層としても用いることが可能である。また、このスチリル化合物を発光層として、電子輸送層と正孔輸送層とで挟み込んだ構成とすることも可能である。図5及び図6は、上記の構成に加えて、発光層5の陰極側に接してフェナントロリン誘導体からなるホールブロッキング層21を設けたものである。

【0054】なお、図1及び図2、図5及び図6中、3は陰極であり、電極材料としては、Li、Mg、Ca等の活性な金属とAg、Al、In等の金属との合金、或

電界発光素子においては、陰極の厚さを調節することにより、用途に合った光透過率を得ることができる。また、図中の4は封止・保護層であり、有機電界発光素子全体を覆う構造とすることにより、その効果が上がる。気密性が保たれば、適宜の材料を使用することができる。また、8は電流注入用の駆動電源である。

【0055】本発明に基づく有機電界発光素子において、有機層が、正孔輸送層と電子輸送層とが積層された有機積層構造（シングルヘテロ構造）を有しており、正孔輸送層又は電子輸送層の形成材料として前記スチリル化合物が用いられてよい。或いは、有機層が、正孔輸送層と発光層と電子輸送層とが順次積層された有機積層構造（ダブルヘテロ構造）を有しており、発光層の形成材料として前記スチリル化合物が用いられてよい。

【0056】このような有機積層構造を有する有機電界発光素子の例を示すと、図3は、透光性の基板1上に、透光性の陽極2と、正孔輸送層6と電子輸送層7とからなる有機層5aと、陰極3とが順次積層された積層構造を有し、この積層構造が保護膜4によって封止されてなる、シングルヘテロ構造の有機電界発光素子Cである。図7では、電子輸送層7及び／又は正孔輸送層6の陰極側に接してホールブロッキング層21が設けられている。

【0057】図3、図7に示すように発光層を省略した層構成の場合には、正孔輸送層6と電子輸送層7の界面から所定波長の発光20を発生する。これらの発光は基板1側から観測される。

【0058】また、図4は、透光性の基板1上に、透光性の陽極2と、正孔輸送層10と発光層11と電子輸送層12とからなる有機層5bと、陰極3とが順次積層された積層構造を有し、この積層構造が保護膜4によって封止されてなる、ダブルヘテロ構造の有機電界発光素子Dである。図8では、発光層11の陰極側に接してホールブロッキング層21が設けられている。

【0059】図4に示した有機電界発光素子においては、陽極2と陰極3の間に直流電圧を印加することにより、陽極2から注入された正孔が正孔輸送層10を経て、また陰極3から注入された電子が電子輸送層12を経て、それぞれ発光層11に到達する。この結果、発光層11においては電子／正孔の再結合が生じて一重項励起子が生成し、この一重項励起子から所定波長の発光を発生する。

【0060】上述した各有機電界発光素子C、Dにおいて、基板1は、例えば、ガラス、プラスチック等の光透過性の材料を適宜用いることができる。また、他の表示素子と組み合わせて用いる場合や、図3及び図4、図7及び図8に示した積層構造をマトリックス状に配置する場合等は、この基板を共用としてよい。また、素子C、Dはいずれも、透過型、反射型のいずれの構造も採



【0061】また、陽極2は、透明電極であり、ITO(indium tin oxide)や $\text{SnO}_2$ 等が使用できる。この陽極2と正孔輸送層6(又は正孔輸送層10)との間には、電荷の注入効率を改善する目的で、有機物若しくは有機金属化合物からなる薄膜を設けてもよい。なお、保護膜4が金属等の導電性材料で形成されている場合は、陽極2の側面に絶縁膜が設けられていてもよい。

【0062】また、有機電界発光素子Cにおける有機層5aは、正孔輸送層6と電子輸送層7とが積層された有機層であり、これらのいずれか又は双方に上記したスチリル化合物が含有され、発光性の正孔輸送層6又は電子輸送層7としてよい。有機電界発光素子Dにおける有機層5bは、正孔輸送層10と上記したスチリル化合物を含有する発光層11と電子輸送層12とが積層された有機層であるが、その他、種々の積層構造を取ることができる。例えば、正孔輸送層と電子輸送層のいずれか若しくは両方が発光性を有していてもよい。

【0063】また、特に、正孔輸送層6又は電子輸送層7や発光層11が前記スチリル化合物からなる層であることが望ましいが、これらの層を前記スチリル化合物のみで形成してもよく、或いは、前記スチリル化合物と他の正孔又は電子輸送材料(例えば、芳香族アミン類やピラゾリン類等)との共蒸着によって形成してもよい。さらに、正孔輸送層において、正孔輸送性能を向上させるために、複数種の正孔輸送材料を積層した正孔輸送層を形成してもよい。

【0064】また、有機電界発光素子Cにおいて、発光層は電子輸送性発光層7であってよいが、電源8から印加される電圧によっては、正孔輸送層6やその界面で発光される場合がある。同様に、有機電界発光素子Dにおいて、発光層は層11以外に、電子輸送層12であってよく、正孔輸送層10であってよい。発光性能を向上させるために、少なくとも1種の蛍光性材料を用いた発光層11を正孔輸送層と電子輸送層との間に挟持させた構造であるのがよい。または、この蛍光性材料を正孔輸送層又は電子輸送層、或いはこれら両層に含有させた構造を構成してよい。このような場合、発光効率を改善するために、正孔又は電子の輸送を制御するための薄膜(ホールプロッキング層やエキシトン生成層など)をその層構成に含ませることも可能である。

【0065】また、陰極3に用いる材料としては、Li、Mg、Ca等の活性な金属とAg、Al、In等の金属との合金を使用でき、これらの金属層が積層した構造であってもよい。なお、陰極の厚みや材質を適宜選択することによって、用途に見合った有機電界発光素子を作製できる。

【0066】また、保護膜4は、封止膜として作用するものであり、有機電界発光素子全体を覆う構造とすることで、電荷注入効率や発光効率を向上できる。なお、そ

単金属又は合金など、適宜その材料を選択できる。

【0067】上記した各有機電界発光素子に印加する電流は通常、直流であるが、パルス電流や交流を用いてもよい。電流値、電圧値は、素子破壊しない範囲内であれば特に制限はないが、有機電界発光素子の消費電力や寿命を考慮すると、なるべく小さい電気エネルギーで効率良く発光させることが望ましい。

【0068】次に、図9は、本発明の有機電界発光素子を用いた平面ディスプレイの構成例である。図示の如く、例えばフルカラーディスプレイの場合は、赤(R)、緑(G)及び青(B)の3原色を発光可能な有機層5(5a、5b)が、陰極3と陽極2との間に配されている。陰極3及び陽極2は、互いに交差するストライプ状に設けることができ、輝度信号回路14及びシフトレジスタ内蔵の制御回路15により選択されて、それぞれに信号電圧が印加され、これによって、選択された陰極3及び陽極2が交差する位置(画素)の有機層が発光するように構成される。

【0069】即ち、図9は例えば $8 \times 3$  RGB単純マトリックスであって、正孔輸送層と、発光層および電子輸送層のいずれか少なくとも一方とからなる積層体5を陰極3と陽極2の間に配置したものである(図3及び図7、又は図4及び図8参照)。陰極と陽極は、ともにストライプ状にパターンニングするとともに、互いにマトリクス状に直交させ、シフトレジスタ内蔵の制御回路15および14により時系列的に信号電圧を印加し、その交叉位置で発光するように構成されたものである。かかる構成のEL素子は、文字・記号等のディスプレイとしては勿論、画像再生装置としても使用できる。また陰極3と陽極2のストライプ状パターンを赤(R)、緑(G)、青(B)の各色毎に配し、マルチカラーあるいはフルカラーの全固体型フラットパネルディスプレイを構成することが可能となる。

【0070】

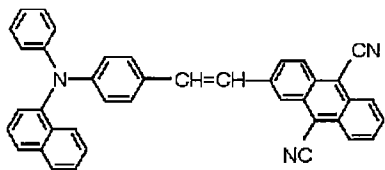
【実施例】以下、本発明を実施例について具体的に説明するが、本発明は以下の実施例に限定されるものではない。

#### 【0071】実施例1

本実施例は、一般式(1)のスチリル化合物のうち、 $R^1$ に無置換フェニル基、 $R^2$ に無置換ナフチル基、Xに9, 10-ジシアノアントラセン基を持った下記構造式(20)-2の化合物を正孔輸送性発光材料として用い、シングルヘテロ構造の有機電界発光素子を作製した例である。

【0072】

【化45】構造式(20)-2：



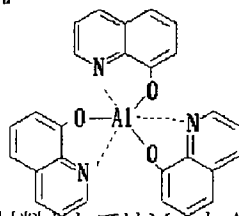
【0073】まず、真空蒸着装置中に、100 nmの厚さのITOからなる陽極が一表面に形成された30 mm×30 mmのガラス基板をセッティングした。蒸着マスクとして、複数の2.0 mm×2.0 mmの単位開口を有する金属マスクを基板に近接して配置し、真空蒸着法により $10^{-4}$  Pa以下の真空下で上記構造式(20)-2の化合物を例えば50 nmの厚さに正孔輸送層(兼発光層)として成膜した。蒸着レートは0.1 nm/秒とした。

【0074】さらに、電子輸送材料として下記構造式のAlq<sub>3</sub>(トリス(8-キノリノール)アルミニウム)を正孔輸送層に接して蒸着した。Alq<sub>3</sub>からなるこの電子輸送層の膜厚も例えば50 nmとし、蒸着レートは0.2 nm/秒とした。

【0075】

【化46】

Alq<sub>3</sub>:



【0076】陰極材料としてはMgとAgの積層膜を採用し、これも蒸着により、蒸着レート1 nm/秒として例えば50 nm(Mg膜)および150 nm(Ag膜)の厚さに形成し、実施例1による図3に示した如き有機電界発光素子を作製した。

【0077】このように作製した実施例1の有機電界発光素子に、窒素雰囲気下で順バイアス直流電圧を加えて発光特性を評価した。発光色は赤色であり、分光測定を行った結果、図10に示すように、710 nmに発光ピークを有するスペクトルを得た。分光測定は、大塚電子社製のフォトダイオードアレイを検出器とした分光器を用いた。また、電圧-輝度測定を行ったところ、図11に示すように、8 Vで1000 cd/m<sup>2</sup>の輝度が得られた。

【0078】この有機電界発光素子を作製後、窒素雰囲気下に1カ月間放置したが、素子劣化は観察されなかった。また、初期輝度300 cd/m<sup>2</sup>で電流値を一定に通電して連続発光し、強制劣化させた際、輝度が半減するまで900時間であった。

【0079】実施例2

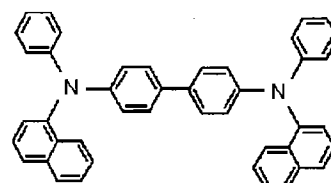
本実施例は、一般式(1)のスチリル化合物のうち、R<sup>1</sup>に無置換フェニル基、R<sup>2</sup>に無置換ナフチル基、Xに

(20)-2の化合物を電子輸送性発光材料として用い、シングルヘテロ構造の有機電界発光素子を作製した例である。

【0080】まず、真空蒸着装置中に、100 nmの厚さのITOからなる陽極が一表面に形成された30 mm×30 mmのガラス基板をセッティングした。蒸着マスクとして、複数の2.0 mm×2.0 mmの単位開口を有する金属マスクを基板に近接して配置し、真空蒸着法により $10^{-4}$  Pa以下の真空下で、下記構造式の $\alpha$ -NPDP( $\alpha$ -ナフチルフェニルジアミン)を例えば50 nmの厚さに正孔輸送層として成膜した。蒸着レートは0.1 nm/秒とした。

【0081】

【化47】 $\alpha$ -NPDP



【0082】さらに、電子輸送材料として上記構造式(20)-2の化合物を正孔輸送層に接して蒸着した。上記構造式(20)-2の化合物からなる電子輸送層(兼発光層)の膜厚も例えば50 nmとし、蒸着レートは0.2 nm/秒とした。

【0083】陰極材料としてはMgとAgの積層膜を採用し、これも蒸着により、蒸着レート1 nm/秒として例えば50 nm(Mg膜)および150 nm(Ag膜)の厚さに形成し、実施例2による図3に示した如き有機電界発光素子を作製した。

【0084】このように作製した実施例2の有機電界発光素子に、窒素雰囲気下で順バイアス直流電圧を加えて発光特性を評価した。発光色は赤色であり、実施例1と同様に分光測定を行った結果、図12に示すように、710 nmに発光ピークを有するスペクトルを得た。また、電圧-輝度測定を行ったところ、図13に示すように、8 Vで800 cd/m<sup>2</sup>の輝度が得られた。

【0085】この有機電界発光素子を作製後、窒素雰囲気下に1カ月間放置したが、素子劣化は観察されなかった。また、初期輝度300 cd/m<sup>2</sup>で電流値を一定に通電して連続発光し、強制劣化させた際、輝度が半減するまで700時間であった。

【0086】実施例3

本実施例は、一般式(1)の上記スチリル化合物のうち、R<sup>1</sup>に無置換フェニル基、R<sup>2</sup>に無置換ナフチル基、Xに9,10-ジシアノアントラセン基を持った上記構造式(20)-2の化合物を発光材料として用い、ダブルヘテロ構造の有機電界発光素子を作製した例である。

【0087】まず、真空蒸着装置中に、100 nmの厚

×30mmのガラス基板をセッティングした。蒸着マスクとして、複数の2.0mm×2.0mmの単位開口を有する金属マスクを基板に近接して配置し、真空蒸着法により $10^{-4}$ Pa以下の真空下で、上記構造式の $\alpha$ -NPDを例えば30nmの厚さに正孔輸送層として成膜した。蒸着レートは0.2nm/秒とした。

【0088】さらに、発光材料として上記構造式(20)-2の化合物を正孔輸送層に接して蒸着した。上記構造式(20)-2の化合物からなる発光層の膜厚も例えば30nmとし、蒸着レートは0.2nm/秒とした。

【0089】さらに、電子輸送材料として上記構造式のAlq<sub>3</sub>を発光層に接して蒸着した。Alq<sub>3</sub>の膜厚を例えば30nmとし、蒸着レートは、0.2nm/秒とした。

【0090】陰極材料としてはMgとAgの積層膜を採用し、これも蒸着により、蒸着レート1nm/秒として例えば50nm(Mg膜)および150nm(Ag膜)の厚さに形成し、実施例3による図4に示した如き有機電界発光素子を作製した。

【0091】このように作製した実施例3の有機電界発光素子に、窒素雰囲気下で順バイアス直流電圧を加えて発光特性を評価した。発光色は赤色であり、分光測定を行った結果、図14に示すように、710nmに発光ピークを有するスペクトルを得た。また、電圧-輝度測定を行ったところ、図15に示すように、8Vで3000cd/m<sup>2</sup>の輝度が得られた。

【0092】この有機電界発光素子を作製後、窒素雰囲気下に1カ月間放置したが、素子劣化は観察されなかった。また、初期輝度300cd/m<sup>2</sup>で電流値を一定に通電して連続発光し、強制劣化させた際、輝度が半減するまで1500時間であった。

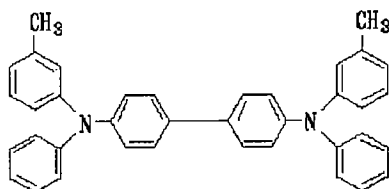
#### 【0093】実施例4

正孔輸送性材料として $\alpha$ -NPDに替えて下記構造式のTPD(トリフェニルジアミン誘導体)を用いた他は層構成、成膜法とも実施例2に準拠して、有機電界発光素子を作製した。

【0094】

【化48】

TPD:

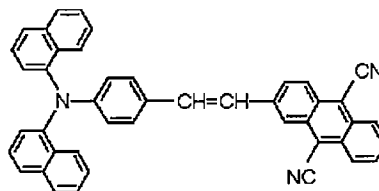


【0095】本実施例の有機電界発光素子も実施例2と同様の赤色の発光を呈した。分光測定の結果、スペクトルは実施例2の有機電界発光素子のスペクトルと一致した。

本実施例は、一般式(1)のスチリル化合物のうち、R<sup>1</sup>、R<sup>2</sup>に無置換ナフチル基、Xに9,10-ジシアノアントラセン基を持った下記構造式(20)-4の化合物を電子輸送性発光材料として用い、これ以外は実施例2と同様にして、シングルヘテロ構造の有機電界発光素子を作製した。

【0097】

【化49】構造式(20)-4:



【0098】このように作製した実施例5の有機電界発光素子に、窒素雰囲気下で順バイアス直流電圧を加えて発光特性を評価した。発光色は赤色であり、分光測定を行った結果、図16に示すように、700nmに発光ピークを有するスペクトルを得た。また、電圧-輝度測定を行ったところ、図17に示すように、7Vで700cd/m<sup>2</sup>の輝度が得られた。

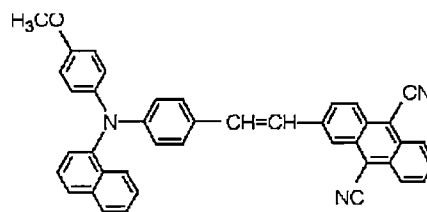
【0099】この有機電界発光素子を作製後、窒素雰囲気下に1カ月間放置したが、素子劣化は観察されなかった。また、初期輝度300cd/m<sup>2</sup>で電流値を一定に通電して連続発光し、強制劣化させた際、輝度が半減するまで500時間であった。

#### 【0100】実施例6

本実施例は、一般式(1)の上記スチリル化合物のうち、R<sup>1</sup>に4-メトキシフェニル基、R<sup>2</sup>に無置換ナフチル基、Xに9,10-ジシアノアントラセン基を持った下記構造式(20)-3の化合物を電子輸送性材料として用い、シングルヘテロ層構造の有機電界発光素子を作製した例である。層構成、成膜法とも、実施例2に準拠して有機電界発光素子を作製した。

【0101】

【化50】構造式(20)-3:



【0102】このように作製した実施例6の有機電界発光素子に、窒素雰囲気下で順バイアス直流電圧を加えて発光特性を評価した。発光色は赤色であり、分光測定を行った結果、図18に示すように、750nmに発光ピークを有するスペクトルを得た。電圧-輝度測定を行ったところ、図19に示すように、7Vで130cd/m<sup>2</sup>の輝度が得られた。

【0103】この有機電界発光素子を作製後、窒素雰囲気

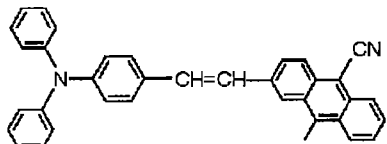
た。

#### 【0104】実施例7

本実施例は、一般式(1)のスチリル化合物のうち、 $R^1$ 、 $R^2$ に無置換フェニル基、Xに9,10-ジシアノアントラセン基を持った下記構造式(20)-1の化合物を電子輸送性発光材料として用い、シングルヘテロ構造の有機電界発光素子を作製した例である。層構造、成膜法とも、実施例2に準拠して有機電界発光素子を作製した。

【0105】

【化51】構造式(20)-1:



【0106】このように作製した実施例7の有機電界発光素子に、窒素雰囲気下で順バイアス直流電圧を加えて発光特性を評価した。発光色は赤色であり、7Vで100cd/m<sup>2</sup>の輝度が得られた。

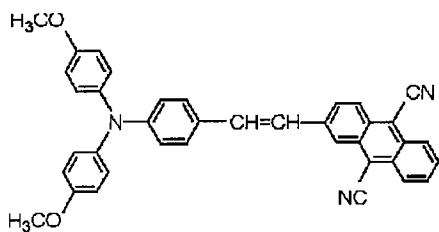
【0107】この有機電界発光素子を作製後、窒素雰囲気下に1カ月間放置したが、素子劣化は観察されなかった。

#### 【0108】実施例8

本実施例は、一般式(1)のスチリル化合物のうち、 $R^1$ 、 $R^2$ に4-メトキシフェニル基、Xに9,10-ジシアノアントラセン基を持った下記構造式(20)-5の化合物を電子輸送性発光材料として用い、シングルヘテロ構造の有機電界発光素子を作製した例である。層構造、成膜法とも、実施例2に準拠して有機電界発光素子を作製した。

【0109】

【化52】構造式(20)-5:



【0110】このように作製した実施例8の有機電界発光素子に、窒素雰囲気下で順バイアス直流電圧を加えて発光特性を評価した。発光色は赤色であり、7Vで80cd/m<sup>2</sup>の輝度が得られた。

【0111】この有機電界発光素子を作製後、窒素雰囲気下に1カ月間放置したが、素子劣化は観察されなかった。

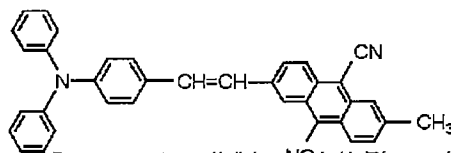
#### 【0112】実施例9

本実施例は、一般式(1)のスチリル化合物のうち、 $R^1$ 、 $R^2$ に無置換フェニル基、Xに2-メチル-9,10-ジシアノアントラセン基を持った下記構造式(20)-6:

シングルヘテロ構造の有機電界発光素子を作製した例である。層構造、成膜法とも、実施例2に準拠して有機電界発光素子を作製した。

【0113】

【化53】構造式(20)-6:



【0114】このように作製した実施例9の有機電界発光素子に、窒素雰囲気下で順バイアス直流電圧を加えて発光特性を評価した。発光色は赤色であり、7Vで120cd/m<sup>2</sup>の輝度が得られた。

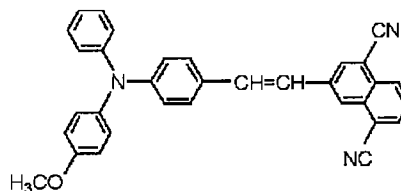
【0115】この有機電界発光素子を作製後、窒素雰囲気下に1カ月間放置したが、素子劣化は観察されなかった。

#### 【0116】実施例10

本実施例は、一般式(1)のスチリル化合物のうち、 $R^1$ に無置換フェニル基、 $R^2$ に4-メトキシフェニル基、Xに1,5-ジシアノナフチル基を持った下記構造式(20)-8の化合物を電子輸送性発光材料として用い、シングルヘテロ構造の有機電界発光素子を作製した例である。層構造、成膜法とも、実施例2に準拠して有機電界発光素子を作製した。

【0117】

【化54】構造式(20)-8:



【0118】このように作製した実施例10の有機電界発光素子に、窒素雰囲気下で順バイアス直流電圧を加えて発光特性を評価した。発光色は赤色であり、7Vで800cd/m<sup>2</sup>の輝度が得られた。

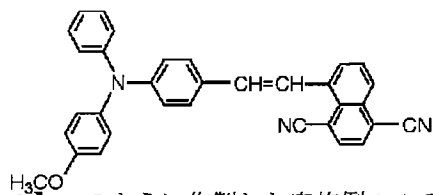
【0119】この有機電界発光素子を作製後、窒素雰囲気下に1カ月間放置したが、素子劣化は観察されなかった。

#### 【0120】実施例11

本実施例は、一般式(1)のスチリル化合物のうち、 $R^1$ に無置換フェニル基、 $R^2$ に4-メトキシフェニル基、Xに1,4-ジシアノナフチル基を持った下記構造式(20)-9の化合物を電子輸送性発光材料として用い、シングルヘテロ構造の有機電界発光素子を作製した例である。層構造、成膜法とも、実施例2に準拠して有機電界発光素子を作製した。

【0121】

【化55】構造式(20)-9:



【0122】このように作製した実施例11の有機電界発光素子に、窒素雰囲気下で順バイアス直流電圧を加えて発光特性を評価した。発光色は赤色であり、7Vで1200cd/m<sup>2</sup>の輝度が得られた。

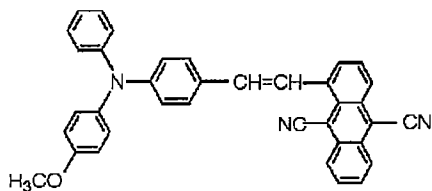
【0123】この有機電界発光素子を作製後、窒素雰囲気下に1カ月間放置したが、素子劣化は観察されなかった。

#### 【0124】実施例12

本実施例は、一般式(1)のスチリル化合物のうち、R<sup>1</sup>に無置換フェニル基、R<sup>2</sup>に4-メトキシフェニル基、Xに9,10-ジシアノアントラセン基を持った下記構造式(20)-10の化合物を電子輸送性発光材料として用い、シングルヘテロ構造の有機電界発光素子を作製した例である。層構造、成膜法とも、実施例2に準拠して有機電界発光素子を作製した。

【0125】

【化56】構造式(20)-10：



【0126】このように作製した実施例12の有機電界発光素子に、窒素雰囲気下で順バイアス直流電圧を加えて発光特性を評価した。発光色は赤色であり、7Vで1500cd/m<sup>2</sup>の輝度が得られた。

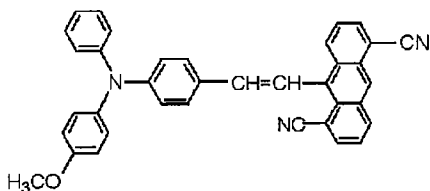
【0127】この有機電界発光素子を作製後、窒素雰囲気下に1カ月間放置したが、素子劣化は観察されなかった。

#### 【0128】実施例13

本実施例は、一般式(1)のスチリル化合物のうち、R<sup>1</sup>に無置換フェニル基、R<sup>2</sup>に4-メトキシフェニル基、Xに2,6-ジシアノンナフチル基を持った下記構造式(20)-11の化合物を電子輸送性発光材料として用い、シングルヘテロ構造の有機電界発光素子を作製した例である。層構造、成膜法とも、実施例2に準拠して有機電界発光素子を作製した。

【0129】

【化57】構造式(20)-11：



発光素子に、窒素雰囲気下で順バイアス直流電圧を加えて発光特性を評価した。発光色は赤色であり、7Vで1700cd/m<sup>2</sup>の輝度が得られた。

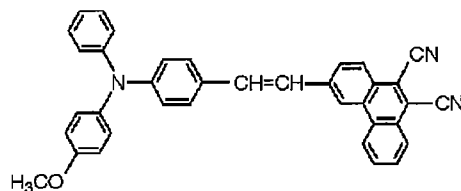
【0131】この有機電界発光素子を作製後、窒素雰囲気下に1カ月間放置したが、素子劣化は観察されなかった。

#### 【0132】実施例14

本実施例は、一般式(1)のスチリル化合物のうち、R<sup>1</sup>に無置換フェニル基、R<sup>2</sup>に4-メトキシフェニル基、Xにフェナントレン基を持った下記構造式(20)-12の化合物を電子輸送性発光材料として用い、シングルヘテロ構造の有機電界発光素子を作製した例である。層構造、成膜法とも、実施例2に準拠して有機電界発光素子を作製した。

【0133】

【化58】構造式(20)-12：



【0134】このように作製した実施例14の有機電界発光素子に、窒素雰囲気下で順バイアス直流電圧を加えて発光特性を評価した。発光色は赤色であり、7Vで2200cd/m<sup>2</sup>の輝度が得られた。

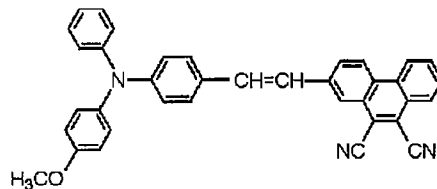
【0135】この有機電界発光素子を作製後、窒素雰囲気下に1カ月間放置したが、素子劣化は観察されなかった。

#### 【0136】実施例15

本実施例は、一般式(1)のスチリル化合物のうち、R<sup>1</sup>に無置換フェニル基、R<sup>2</sup>に4-メトキシフェニル基、Xにフェナントレン基を持った下記構造式(20)-13の化合物を電子輸送性発光材料として用い、シングルヘテロ構造の有機電界発光素子を作製した例である。層構造、成膜法とも、実施例2に準拠して有機電界発光素子を作製した。

【0137】

【化59】構造式(20)-13：



【0138】このように作製した実施例15の有機電界発光素子に、窒素雰囲気下で順バイアス直流電圧を加えて発光特性を評価した。発光色は赤色であり、7Vで2100cd/m<sup>2</sup>の輝度が得られた。

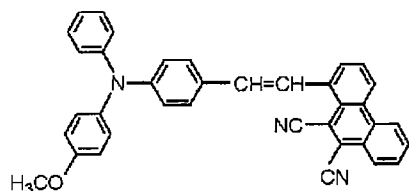
【0139】この有機電界発光素子を作製後、窒素雰囲気下に1カ月間放置したが、素子劣化は観察されなかった。

#### 【0140】実施例16

本実施例は、一般式(1)のスチリル化合物のうち、 $R^1$ に無置換フェニル基、 $R^2$ に4-メトキシフェニル基、Xにフェナントレン基を持った下記構造式(20)-14の化合物を電子輸送性発光材料として用い、シングルヘテロ構造の有機電界発光素子を作製した例である。層構造、成膜法とも、実施例2に準拠して有機電界発光素子を作製した。

【0141】

【化60】構造式(20)-14:



【0142】このように作製した実施例16の有機電界発光素子に、窒素雰囲気下で順バイアス直流電圧を加えて発光特性を評価した。発光色は赤色であり、7Vで1800cd/m<sup>2</sup>の輝度が得られた。

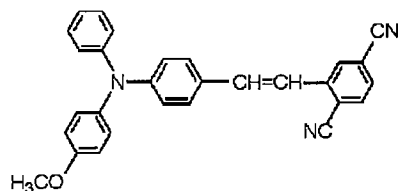
【0143】この有機電界発光素子を作製後、窒素雰囲気下に1カ月間放置したが、素子劣化は観察されなかった。

#### 【0144】実施例17

本実施例は、一般式(1)のスチリル化合物のうち、 $R^1$ に無置換フェニル基、 $R^2$ に4-メトキシフェニル基、Xにジシアノフェニル基を持った下記構造式(20)-15の化合物を電子輸送性発光材料として用い、シングルヘテロ構造の有機電界発光素子を作製した例である。層構造、成膜法とも、実施例2に準拠して有機電界発光素子を作製した。

【0145】

【化61】構造式(20)-15:



【0146】このように作製した実施例17の有機電界発光素子に、窒素雰囲気下で順バイアス直流電圧を加えて発光特性を評価した。発光色は赤色であり、8Vで4800cd/m<sup>2</sup>の輝度が得られた。

【0147】この有機電界発光素子を作製後、窒素雰囲気下に1カ月間放置したが、素子劣化は観察されなかった。

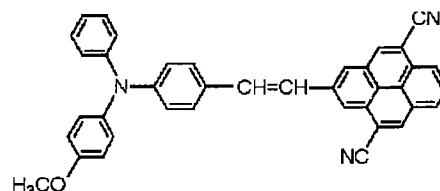
#### 【0148】実施例18

本実施例は、一般式(1)のスチリル化合物のうち、 $R^1$ に無置換フェニル基、 $R^2$ に4-メトキシフェニル基、Xにジシアノ置換ビレニル基を持った下記構造式(20)-16の化合物を電子輸送性発光材料として用

例である。層構造、成膜法とも、実施例2に準拠して有機電界発光素子を作製した。

【0149】

【化62】構造式(20)-16:



【0150】このように作製した実施例18の有機電界発光素子に、窒素雰囲気下で順バイアス直流電圧を加えて発光特性を評価した。発光色は赤色であり、8Vで800cd/m<sup>2</sup>の輝度が得られた。

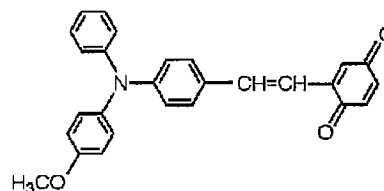
【0151】この有機電界発光素子を作製後、窒素雰囲気下に1カ月間放置したが、素子劣化は観察されなかった。

#### 【0152】実施例19

本実施例は、一般式(1)のスチリル化合物のうち、 $R^1$ に無置換フェニル基、 $R^2$ に4-メトキシフェニル基、Xにキノンをを持った下記構造式(20)-17の化合物を電子輸送性発光材料として用い、シングルヘテロ構造の有機電界発光素子を作製した例である。層構造、成膜法とも、実施例2に準拠して有機電界発光素子を作製した。

【0153】

【化63】構造式(20)-17:



【0154】このように作製した実施例19の有機電界発光素子に、窒素雰囲気下で順バイアス直流電圧を加えて発光特性を評価した。発光色は赤色であり、8Vで1500cd/m<sup>2</sup>の輝度が得られた。

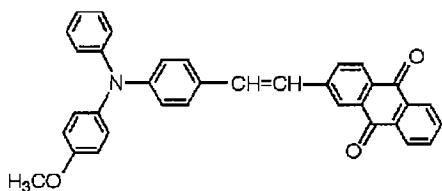
【0155】この有機電界発光素子を作製後、窒素雰囲気下に1カ月間放置したが、素子劣化は観察されなかった。

#### 【0156】実施例20

本実施例は、一般式(1)のスチリル化合物のうち、 $R^1$ に無置換フェニル基、 $R^2$ に4-メトキシフェニル基、Xにアントラキノンをを持った下記構造式(20)-18の化合物を電子輸送性発光材料として用い、シングルヘテロ構造の有機電界発光素子を作製した例である。層構造、成膜法とも、実施例2に準拠して有機電界発光素子を作製した。

【0157】

【化64】構造式(20)-18:



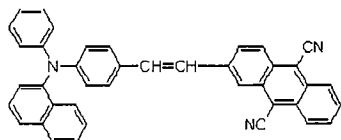
【0158】このように作製した実施例20の有機電界発光素子に、窒素雰囲気下で順バイアス直流電圧を加えて発光特性を評価した。発光色は赤色であり、8 Vで1800 cd/m<sup>2</sup>の輝度が得られた。

【0159】この有機電界発光素子を作製後、窒素雰囲気下に1カ月間放置したが、素子劣化は観察されなかった。

#### 【0160】実施例21

本実施例は、一般式[I]の上記アミノスチリル化合物のうち、下記構造式(37)-1の化合物を正孔輸送性発光層として用いた有機電界発光素子を作製した例である。

【化65】構造式(37)-1:

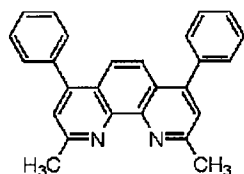


【0161】まず、真空蒸着装置中に、100 nmの厚さのITOからなる陽極が一表面に形成された30 mm×30 mmのガラス基板をセッティングした。蒸着マスクとして複数の2.0 mm×2.0 mmの単位開口を有する金属マスクを基板に近接して配置し、真空蒸着法により10<sup>-4</sup> Pa以下の真空下で上記構造式(37)-1を例えば50 nmの厚さに正孔輸送層(兼発光層)として成膜した。蒸着レートは各々0.1 nm/秒とした。

【0162】さらに、ホールブロッキング層材料として下記構造式のバソクプロインを正孔輸送層に接して蒸着した。バソクプロインからなるこのホールブロッキング層の膜厚は例えば15 nmとし、蒸着レートは0.1 nm/秒とした。

【0163】さらに、電子輸送層材料として上記構造式のAlq<sub>3</sub>(トリス(8-キノリノール)アルミニウム)をホールブロッキング層に接して蒸着した。Alq<sub>3</sub>からなるこの電子輸送層の膜厚も例えば50 nmとし、蒸着レートは0.2 nm/秒とした。

【化66】バソクプロイン:



【0164】陰極材料としてはMgとAgの積層膜を採用し、これも蒸着により、蒸着レート1 nm/秒として例えば50 nm(Mg膜)および150 nm(Ag膜)

機電界発光素子を作製した。

【0165】このように作製した実施例21の有機電界発光素子に、窒素雰囲気下で順バイアス直流電圧を加えて発光特性を評価した。発光色は赤色であり、分光測定を行った結果、710 nm付近に発光ピークを有するスペクトルを得た。分光測定は、大塚電子社製のフォトダイオードアレイを検出器とした分光器を用いた。また、電圧-輝度測定を行ったところ、8 Vで800 cd/m<sup>2</sup>の輝度が得られた。

【0166】この有機電界発光素子を作製後、窒素雰囲気下に1カ月間放置したが、素子劣化は観察されなかった。また、初期輝度100 cd/m<sup>2</sup>で電流値を一定に通電して連続発光し、強制劣化させた際、輝度が半減するまで800時間であった。

#### 【0167】実施例22

本実施例は、一般式[I]の化合物のうち、下記構造式(37)-1の化合物を電子輸送性発光層として用いた有機電界発光素子を作製した例である。

【0168】まず、真空蒸着装置中に、100 nmの厚さのITOからなる陽極が一表面に形成された30 mm×30 mmのガラス基板をセッティングした。蒸着マスクとして複数の2.0 mm×2.0 mmの単位開口を有する金属マスクを基板に近接して配置し、真空蒸着法により10<sup>-4</sup> Pa以下の真空下で上記構造式のα-NPDを例えば30 nmの厚さに成膜した。蒸着レートは0.1 nm/秒とした。

【0169】さらに、上記構造式(37)-1の化合物を正孔輸送層に接して蒸着した。この構造式(37)-1の化合物からなる電子輸送層(兼発光層)の膜厚も例えば30 nmとし、蒸着レートは各々0.2 nm/秒とした。

【0170】さらに、ホールブロッキング層材料として上記構造式のバソクプロインを発光層に接して蒸着した。バソクプロインからなるこのホールブロッキング層の膜厚は例えば15 nmとし、蒸着レートは0.1 nm/秒とした。さらに、電子輸送層材料として上記構造式のAlq<sub>3</sub>をホールブロッキング層に接して蒸着した。Alq<sub>3</sub>からなるこの電子輸送層の膜厚も例えば30 nmとし、蒸着レートは0.2 nm/秒とした。

【0171】陰極材料としてはMgとAgの積層膜を採用し、これも蒸着により、蒸着レート1 nm/秒として例えば50 nm(Mg)および150 nm(Ag膜)の厚さに形成し、図8に示した如き有機電界発光素子を作製した。

【0172】このように作製した実施例22の有機電界発光素子に、窒素雰囲気下で順バイアス直流電圧を加えて発光特性を評価した。発光色は赤色であり、実施例21と同様に分光測定を行った結果、710 nm付近に発光ピークを有するスペクトルを得た。また、電圧-輝度

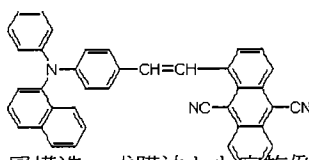
得られた。

【0173】この有機電界発光素子を作製後、窒素雰囲気下に1カ月間放置したが、素子劣化は観察されなかった。また、初期輝度 $100\text{ cd/m}^2$ で電流値を一定に通電して連続発光し、強制劣化させた際、輝度が半減するまで700時間であった。

#### 【0174】実施例23

本実施例は、一般式[1]の上記アミノスチリル化合物のうち、下記構造式(37)-2の化合物を電子輸送性発光層として用いた有機電界発光素子を作製した例である。

#### 【化67】構造式(37)-2:



【0175】層構造、成膜法とも実施例22に準拠して有機電界発光素子を作製した。

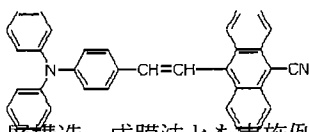
【0176】このように作製した実施例23の有機電界発光素子に、窒素雰囲気下で順バイアス直流電圧を加えて発光特性を評価した。発光色は赤色であり、実施例21と同様に分光測定を行った結果、680nm付近に発光ピークを有するスペクトルを得た。また、電圧-輝度測定を行ったところ、8Vで $500\text{ cd/m}^2$ の輝度が得られた。

【0177】この有機電界発光素子を作製後、窒素雰囲気下に1カ月間放置したが、素子劣化は観察されなかった。また、初期輝度 $100\text{ cd/m}^2$ で電流値を一定に通電して連続発光し、強制劣化させた際、輝度が半減するまで400時間であった。

#### 【0178】実施例24

本実施例は、一般式[1]の上記アミノスチリル化合物のうち、下記構造式(37)-3の化合物を電子輸送性発光層として用いた有機電界発光素子を作製した例である。

#### 【化68】構造式(37)-3:



【0179】層構造、成膜法とも実施例22に準拠して有機電界発光素子を作製した。

【0180】このように作製した実施例24の有機電界発光素子に、窒素雰囲気下で順バイアス直流電圧を加えて発光特性を評価した。発光色は橙色であり、実施例21と同様に分光測定を行った結果、620nm付近に発光ピークを有するスペクトルを得た。また、電圧-輝度測定を行ったところ、8Vで $700\text{ cd/m}^2$ の輝度が得られた。

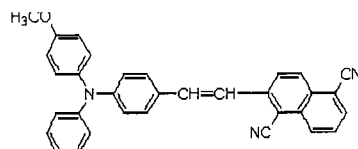
【0181】この有機電界発光素子を作製後、窒素雰囲気

下で、初期輝度 $100\text{ cd/m}^2$ で電流値を一定に通電して連続発光し、強制劣化させた際、輝度が半減するまで400時間であった。

#### 【0182】実施例25

本実施例は、一般式[1]の上記アミノスチリル化合物のうち、下記構造式(37)-4の化合物を電子輸送性発光層として用いた有機電界発光素子を作製した例である。

#### 【化69】構造式(37)-4:



【0183】層構造、成膜法とも実施例22に準拠して有機電界発光素子を作製した。

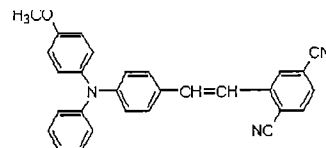
【0184】このように作製した実施例25の有機電界発光素子に、窒素雰囲気下で順バイアス直流電圧を加えて発光特性を評価した。発光色は赤色であり、実施例21と同様に分光測定を行った結果、630nm付近に発光ピークを有するスペクトルを得た。また、電圧-輝度測定を行ったところ、8Vで $2000\text{ cd/m}^2$ の輝度が得られた。

【0185】この有機電界発光素子を作製後、窒素雰囲気下に1カ月間放置したが、素子劣化は観察されなかった。また、初期輝度 $100\text{ cd/m}^2$ で電流値を一定に通電して連続発光し、強制劣化させた際、輝度が半減するまで800時間であった。

#### 【0186】実施例26

本実施例は、一般式[1]の上記アミノスチリル化合物のうち、下記構造式(37)-6の化合物を電子輸送性発光層として用いた有機電界発光素子を作製した例である。

#### 【化70】構造式(37)-6:



【0187】層構造、成膜法とも実施例22に準拠して有機電界発光素子を作製した。

【0188】このように作製した実施例26の有機電界発光素子に、窒素雰囲気下で順バイアス直流電圧を加えて発光特性を評価した。発光色は橙色であり、実施例21と同様に分光測定を行った結果、610nm付近に発光ピークを有するスペクトルを得た。また、電圧-輝度測定を行ったところ、8Vで $2000\text{ cd/m}^2$ の輝度が得られた。

【0189】この有機電界発光素子を作製後、窒素雰囲気下に1カ月間放置したが、素子劣化は観察されなかった。また、初期輝度 $100\text{ cd/m}^2$ で電流値を一定に

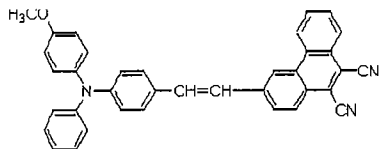


るまで550時間であった。

#### 【0190】実施例27

本実施例は、一般式[Ⅰ]の上記アミノスチリル化合物のうち、下記構造式(37)-7の化合物を電子輸送性発光層として用いた有機電界発光素子を作製した例である。

#### 【化71】構造式(37)-7:



【0191】層構造、成膜法とも実施例22に準拠して有機電界発光素子を作製した。

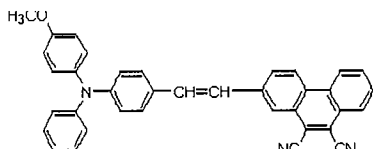
【0192】このように作製した実施例27の有機電界発光素子に、窒素雰囲気下で順バイアス直流電圧を加えて発光特性を評価した。発光色は赤色であり、実施例21と同様に分光測定を行った結果、650nm付近に発光ピークを有するスペクトルを得た。また、電圧-輝度測定を行ったところ、8Vで700cd/m<sup>2</sup>の輝度が得られた。

【0193】この有機電界発光素子を作製後、窒素雰囲気下に1カ月間放置したが、素子劣化は観察されなかった。また、初期輝度100cd/m<sup>2</sup>で電流値を一定に通電して連続発光し、強制劣化させた際、輝度が半減するまで400時間であった。

#### 【0194】実施例28

本実施例は、一般式[Ⅰ]の上記アミノスチリル化合物のうち、下記構造式(37)-8の化合物を電子輸送性発光層として用いた有機電界発光素子を作製した例である。

#### 【化72】構造式(37)-8:



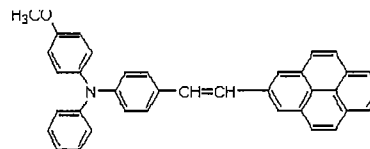
【0195】層構造、成膜法とも実施例22に準拠して有機電界発光素子を作製した。

【0196】このように作製した実施例28の有機電界発光素子に、窒素雰囲気下で順バイアス直流電圧を加えて発光特性を評価した。発光色は赤色であり、実施例21と同様に分光測定を行った結果、650nm付近に発光ピークを有するスペクトルを得た。また、電圧-輝度測定を行ったところ、8Vで650cd/m<sup>2</sup>の輝度が得られた。

【0197】この有機電界発光素子を作製後、窒素雰囲気下に1カ月間放置したが、素子劣化は観察されなかった。また、初期輝度100cd/m<sup>2</sup>で電流値を一定に通電して連続発光し、強制劣化させた際、輝度が半減するまで800時間であった。

本実施例は、一般式[Ⅰ]の上記アミノスチリル化合物のうち、下記構造式(37)-11の化合物を電子輸送性発光層として用いた有機電界発光素子を作製した例である。

#### 【化73】構造式(37)-11:



【0199】層構造、成膜法とも実施例22に準拠して有機電界発光素子を作製した。

【0200】このように作製した実施例29の有機電界発光素子に、窒素雰囲気下で順バイアス直流電圧を加えて発光特性を評価した。発光色は橙色であり、実施例21と同様に分光測定を行った結果、590nm付近に発光ピークを有するスペクトルを得た。また、電圧-輝度測定を行ったところ、8Vで730cd/m<sup>2</sup>の輝度が得られた。

【0201】この有機電界発光素子を作製後、窒素雰囲気下に1カ月間放置したが、素子劣化は観察されなかった。また、初期輝度100cd/m<sup>2</sup>で電流値を一定に通電して連続発光し、強制劣化させた際、輝度が半減するまで850時間であった。

#### 【0202】

【発明の作用効果】本発明の有機電界発光素子によれば、発光領域を有する有機層が陽極と陰極との間に設けられている有機電界発光素子において、前記有機層に前記一般式(1)又は[Ⅰ]で表されるスチリル化合物の少なくとも1種が含まれているので、高輝度で安定な赤色発光を有する有機電界発光素子を提供することができる。

#### 【図面の簡単な説明】

【図1】本発明に基づく有機電界発光素子の一例の要部概略断面図である。

【図2】同、有機電界発光素子の他の例の要部概略断面図である。

【図3】同、有機電界発光素子の他の例の要部概略断面図である。

【図4】同、有機電界発光素子の他の例の要部概略断面図である。

【図5】同、有機電界発光素子の他の例の要部概略断面図である。

【図6】同、有機電界発光素子の他の例の要部概略断面図である。

【図7】同、有機電界発光素子の他の例の要部概略断面図である。

【図8】同、有機電界発光素子の更に他の例の要部概略断面図である。

【図9】同、有機電界発光素子を用いたフルカラーの平

【図10】本発明の実施例1による有機電界発光素子の発光スペクトル図である。

【図11】同、実施例1による有機電界発光素子の電圧－輝度特性図である。

【図12】同、実施例2による有機電界発光素子の発光スペクトル図である。

【図13】同、実施例2による有機電界発光素子の電圧－輝度特性図である。

【図14】同、実施例3による有機電界発光素子の発光スペクトル図である。

【図15】同、実施例3による有機電界発光素子の電圧－輝度特性図である。

【図16】同、実施例5による有機電界発光素子の発光スペクトル図である。

【図17】同、実施例5による有機電界発光素子の電圧－輝度特性図である。

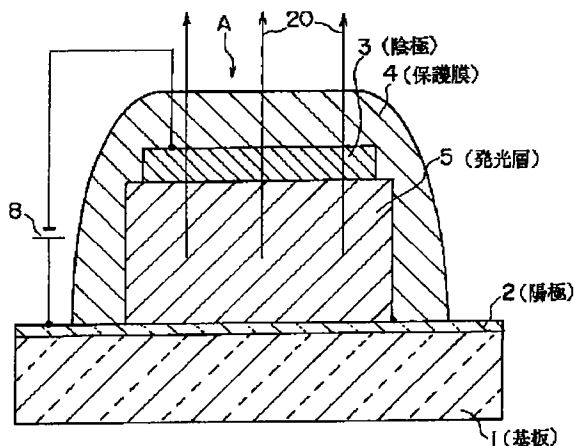
【図18】同、実施例6による有機電界発光素子の発光スペクトル図である。

【図19】同、実施例6による有機電界発光素子の電圧－輝度特性図である。

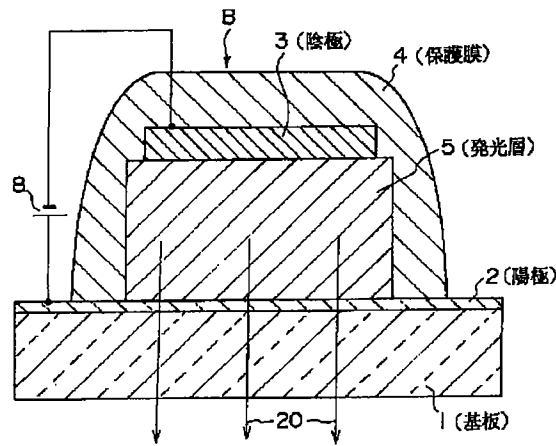
【符号の説明】

1…基板、2…透明電極（陽極）、3…陰極、4…保護膜、5、5a、5b…有機層、6…正孔輸送層、7…電子輸送層、8…電源、10…正孔輸送層、11…発光層、12…電子輸送層、14…輝度信号回路、15…制御回路、20…発光光、21…ホール（正孔）ブロッキング層、A、B、C、D…有機電界発光素子

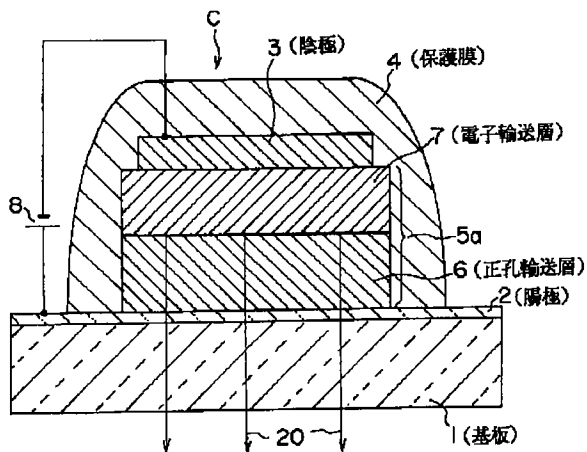
【図1】



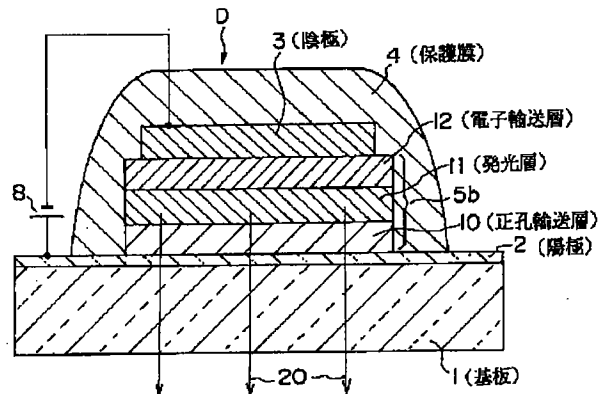
【図2】



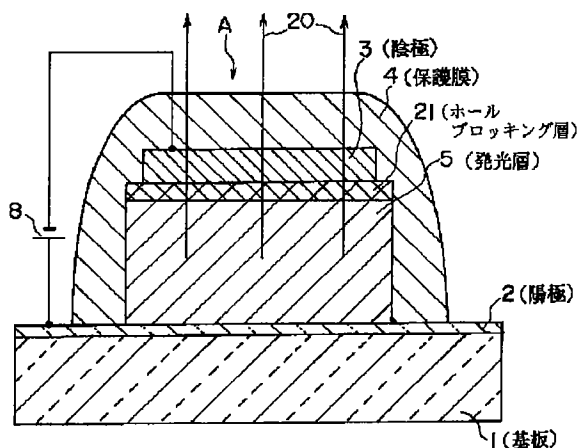
【図3】



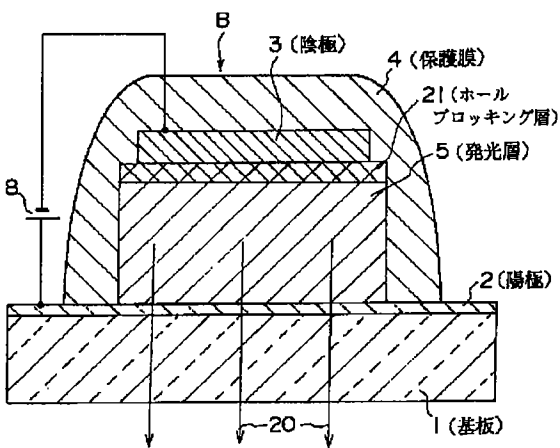
【図4】



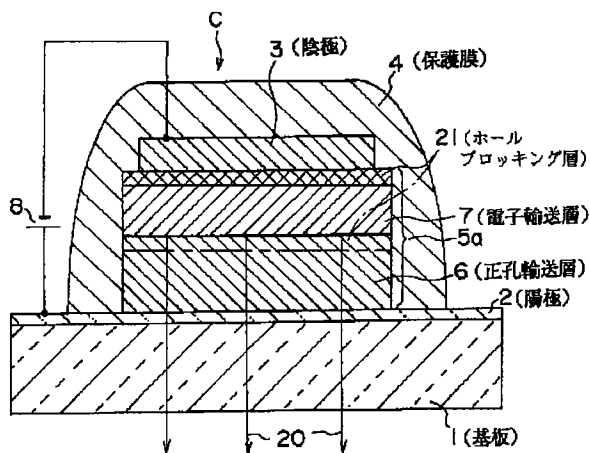
【図5】



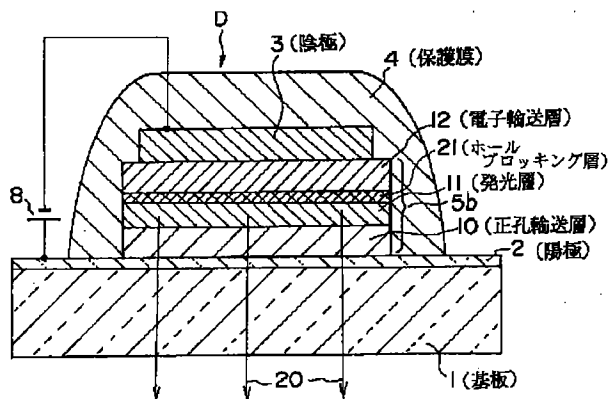
【図6】



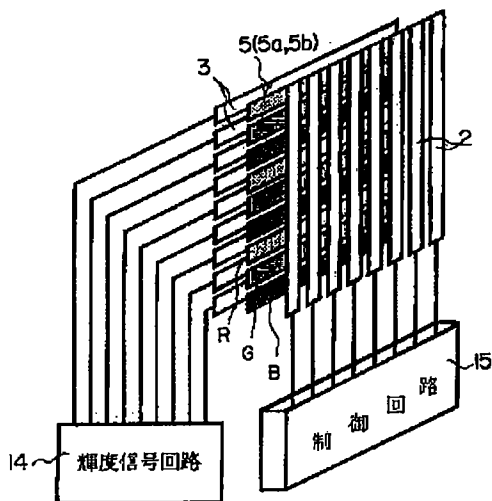
【図7】



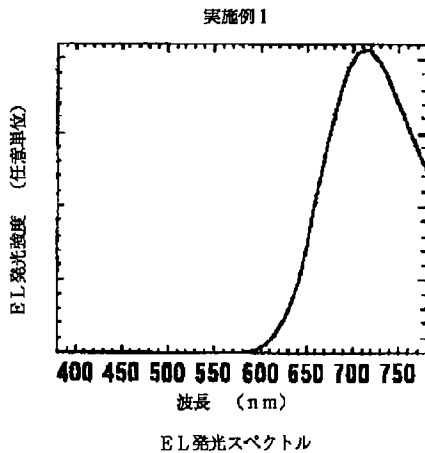
【図8】



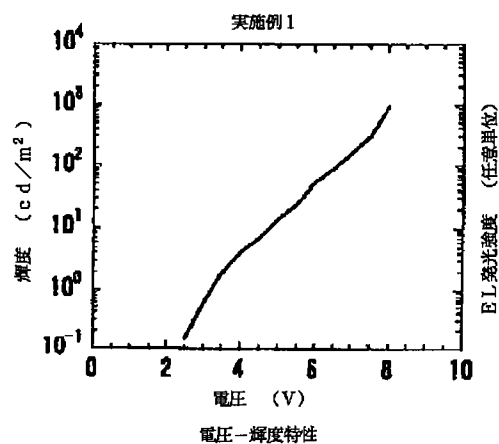
【図9】



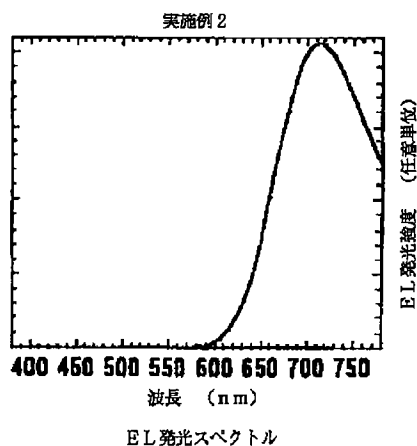
【図10】



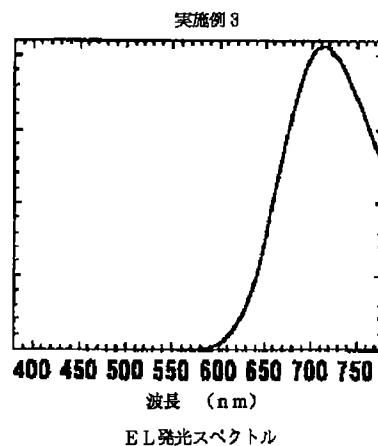
【図 1 1】



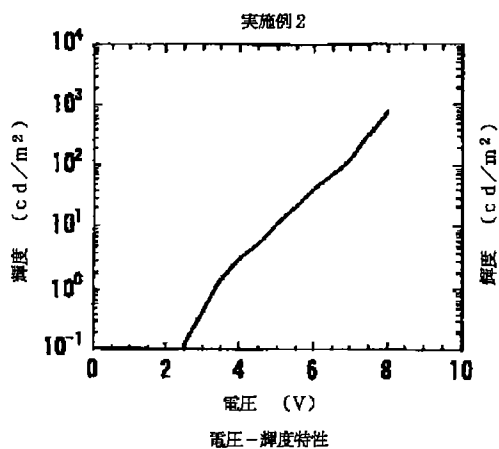
【図 1 2】



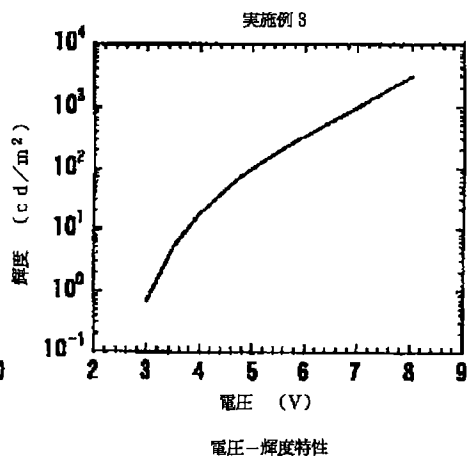
【図 1 4】



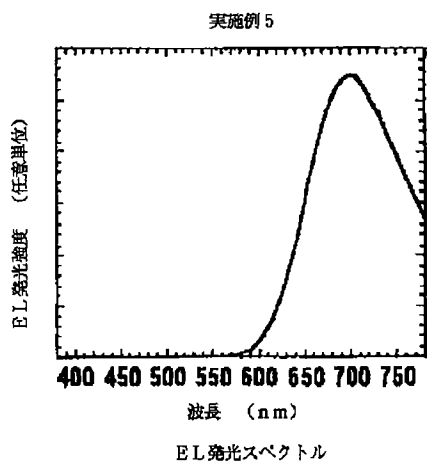
【図 1 3】



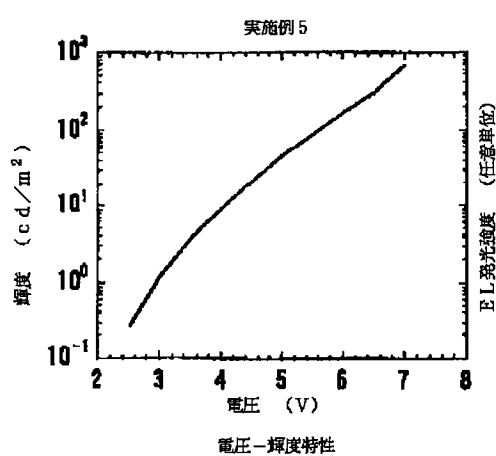
【図 1 5】



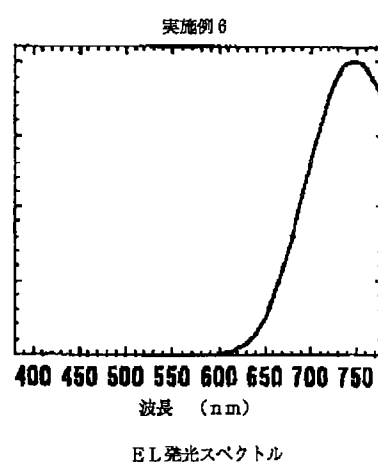
【図 1 6】



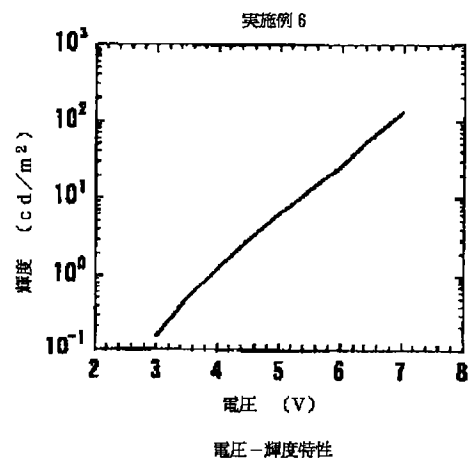
【図 1 7】



【図 1 8】



【図 19】



フロントページの続き

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(22)Date of filing : 28.07.2000 (72)Inventor : ISHIBASHI TADASHI

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TAMURA SHINICHIRO

UEDA NAOYUKI

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(30)Priority

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Priority date : 30.07.1999

Priority country : JP

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(54) ORGANIC FIELD LIGHT EMITTING ELEMENT

(57)Abstract:

PROBLEM TO BE SOLVED: To provide an organic electric field light emitting element yielding red light with stable and large light brightness.

SOLUTION: The organic electric field light emitting element contains in its organic layers 5, 5a and 5b with light-emitting regions, one of styryl compounds which can be represented by the following formula 1. Wherein R1 and R2 are the

aryl group shown by the general formulas 2, 3, or 4. In the formulas, R3 through R21 are specific substituted group including hydrogen atoms and methoxy groups, and X is a substituted or non-substituted aryl group or hydrocarbon ring.

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LEGAL STATUS [Date of request for examination] 26.01.2004

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[Date of final disposal for application]

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[Date of registration] 15.09.2006

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[Date of requesting appeal against examiner's decision of rejection]

[Date of extinction of right]

\* NOTICES \*



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2.\*\*\*\* shows the word which can not be translated.

3.In the drawings, any words are not translated.

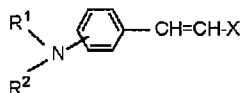
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## CLAIMS

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[Claim(s)]

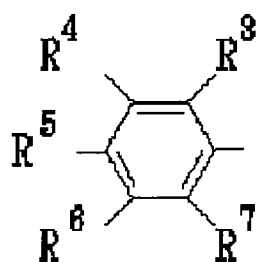
[Claim 1] Organic electroluminescence devices characterized by containing at least one sort of the styryl compound of the unsymmetrical structure expressed with said organic layer by the following general formula (1) as an organic luminescent material in the organic electroluminescence devices by which the organic layer which has a luminescence field is prepared between an anode plate and cathode.



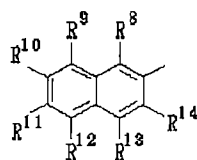
[Formula 1] General formula (1) :

[ -- however, said general formula (1) -- setting -- R1 and R2 -- mutual -- identities -- or the aryl group which is a different radical and is expressed with the following general formula (2), (3), or (4) -- it is -- [Formula 2]

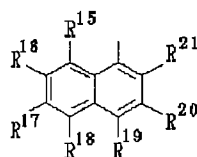
一般式 (2) :



一般式 (3) :



一般式 (4) :



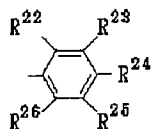
said general formula (2), (3), and (4) -- setting -- R<sup>3</sup> and R<sup>4</sup> -- [ however, ] R<sup>5</sup>, R<sup>6</sup>, R<sup>7</sup>, R<sup>8</sup>, R<sup>9</sup>, and R<sup>10</sup>, R<sup>11</sup>, R<sup>12</sup>, R<sup>13</sup>, R<sup>14</sup>, R<sup>15</sup>, R<sup>16</sup>, R<sup>17</sup>, R<sup>18</sup>, R<sup>19</sup>, R<sup>20</sup> and R<sup>21</sup> are radicals which are identical mutually or are different. they are a hydrogen atom, saturation or a partial saturation alkoxyl group, an alkyl group, the amino group, an alkylamino radical, or an aryl group. X is the aryl group or hydrocarbon ring machine which is not permuted [ a permutation or ]. ]

[Claim 2] Organic electroluminescence devices to which X in said general formula (1) is expressed with the following general formula (5) and which were

indicated to claim 1.

[Formula 3]

一般式 (5) :

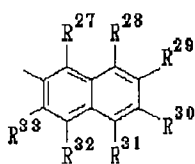


(However, in said general formula (5), R<sup>22</sup>, R<sup>23</sup>, R<sup>24</sup>, R<sup>25</sup>, and R<sup>26</sup> are radicals which are identical mutually or are different, and those at least one is a cyano group, a nitro group, or a halogen atom.)

[Claim 3] Organic electroluminescence devices to which X in said general formula (1) is expressed with the following general formula (6) and which were indicated to claim 1.

[Formula 4]

一般式 (6) :



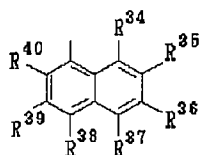
(However, in said general formula (6), R<sup>27</sup>, R<sup>28</sup>, R<sup>29</sup>, R<sup>30</sup>, R<sup>31</sup>, R<sup>32</sup>, and R<sup>33</sup> are radicals which are identical mutually or are different, and hydrogen atoms or those at least one are a cyano group, a nitro group, or a halogen atom.)

[Claim 4] Organic electroluminescence devices to which X in said general

formula (1) is expressed with the following general formula (7) and which were indicated to claim 1.

[Formula 5]

一般式 (7) :

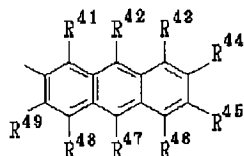


(However, in said general formula (7), R<sup>34</sup>, R<sup>35</sup>, R<sup>36</sup>, R<sup>37</sup>, R<sup>38</sup>, R<sup>39</sup>, and R<sup>40</sup> are radicals which are identical mutually or are different, and hydrogen atoms or those at least one are a cyano group, a nitro group, or a halogen atom.)

[Claim 5] Organic electroluminescence devices to which X in said general formula (1) is expressed with the following general formula (8) and which were indicated to claim 1.

[Formula 6]

一般式 (8) :

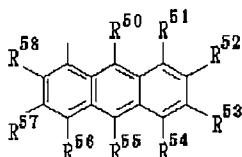


(However, in said general formula (8), R<sup>41</sup>, R<sup>42</sup>, R<sup>43</sup>, R<sup>44</sup>, R<sup>45</sup>, R<sup>46</sup>, R<sup>47</sup>, R<sup>48</sup>, and R<sup>49</sup> are radicals which are identical mutually or are different, and hydrogen atoms or those at least one are a cyano group, a nitro group, or a halogen atom.)

[Claim 6] Organic electroluminescence devices to which X in said general formula (1) is expressed with the following general formula (9) and which were indicated to claim 1.

[Formula 7]

一般式 (9) :

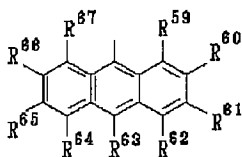


(However, in said general formula (9), R<sub>50</sub>, R<sub>51</sub>, R<sub>52</sub>, R<sub>53</sub>, R<sub>54</sub>, R<sub>55</sub>, R<sub>56</sub>, R<sub>57</sub>, and R<sub>58</sub> are radicals which are identical mutually or are different, and hydrogen atoms or those at least one are a cyano group, a nitro group, or a halogen atom.)

[Claim 7] Organic electroluminescence devices to which X in said general formula (1) is expressed with the following general formula (10) and which were indicated to claim 1.

[Formula 8]

一般式 (10) :



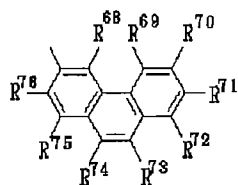
(However, in said general formula (10), R<sub>59</sub>, R<sub>60</sub>, R<sub>61</sub>, R<sub>62</sub>, R<sub>63</sub>, R<sub>64</sub>, R<sub>65</sub>, R<sub>66</sub>, and R<sub>67</sub> are radicals which are identical mutually or are different, and

hydrogen atoms or those at least one are a cyano group, a nitro group, or a halogen atom.)

[Claim 8] Organic electroluminescence devices to which X in said general formula (1) is expressed with the following general formula (11) and which were indicated to claim 1.

[Formula 9]

一般式 (11) :

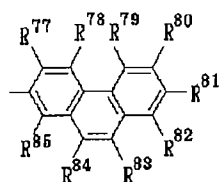


(However, in said general formula (11), R68, R69, R70, R71, R72, R73, R74, R75, and R76 are radicals which are identical mutually or are different, and hydrogen atoms or those at least one are a cyano group, a nitro group, or a halogen atom.)

[Claim 9] Organic electroluminescence devices to which X in said general formula (1) is expressed with the following general formula (12) and which were indicated to claim 1.

[Formula 10]

一般式 (12) :

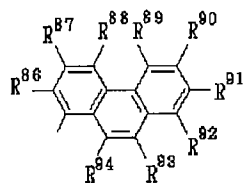


(However, in said general formula (12), R77, R78, R79, R80, R81, R82, R83, R84, and R85 are radicals which are identical mutually or are different, and hydrogen atoms or those at least one are a cyano group, a nitro group, or a halogen atom.)

[Claim 10] Organic electroluminescence devices to which X in said general formula (1) is expressed with the following general formula (13) and which were indicated to claim 1.

[Formula 11]

一般式 (13) :

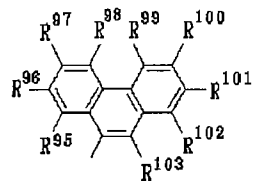


(However, in said general formula (13), R86, R87, R88, R89, R90, R91, R92, R93, and R94 are radicals which are identical mutually or are different, and hydrogen atoms or those at least one are a cyano group, a nitro group, or a halogen atom.)

[Claim 11] Organic electroluminescence devices to which X in said general formula (1) is expressed with the following general formula (14) and which were indicated to claim 1.

[Formula 12]

一般式 (14) :

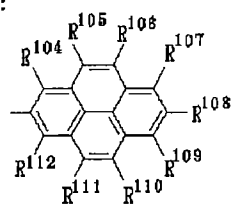


(However, in said general formula (14), R<sub>95</sub>, R<sub>96</sub>, R<sub>97</sub>, R<sub>98</sub>, R<sub>99</sub>, R<sub>100</sub>, R<sub>101</sub>, R<sub>102</sub>, and R<sub>103</sub> are radicals which are identical mutually or are different, and hydrogen atoms or those at least one are a cyano group, a nitro group, or a halogen atom.)

[Claim 12] Organic electroluminescence devices to which X in said general formula (1) is expressed with the following general formula (15) and which were indicated to claim 1.

[Formula 13]

一般式 (15) :



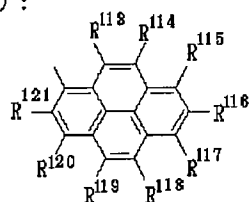
(However, in said general formula (15), R<sub>104</sub>, R<sub>105</sub>, R<sub>106</sub>, R<sub>107</sub>, R<sub>108</sub>, R<sub>109</sub>, R<sub>110</sub>, R<sub>111</sub>, and R<sub>112</sub> are radicals which are identical mutually or are different, and hydrogen atoms or those at least one are a cyano group, a nitro group, or a halogen atom.)



[Claim 13] Organic electroluminescence devices to which X in said general formula (1) is expressed with the following general formula (16) and which were indicated to claim 1.

[Formula 14]

一般式 (16) :

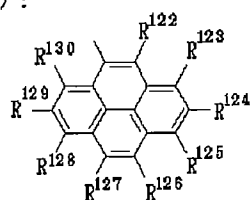


(However, in said general formula (16), R<sup>113</sup>, R<sup>114</sup>, R<sup>115</sup>, R<sup>116</sup>, R<sup>117</sup>, R<sup>118</sup>, R<sup>119</sup>, R<sup>120</sup>, and R<sup>121</sup> are radicals which are identical mutually or are different, and hydrogen atoms or those at least one are a cyano group, a nitro group, or a halogen atom.)

[Claim 14] Organic electroluminescence devices to which X in said general formula (1) is expressed with the following general formula (17) and which were indicated to claim 1.

[Formula 15]

一般式 (17) :



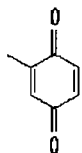
(However, in said general formula (17), R<sup>122</sup>, R<sup>123</sup>, R<sup>124</sup>, R<sup>125</sup>, R<sup>126</sup>, R<sup>127</sup>,

R128, R129, and R130 are radicals which are identical mutually or are different, and hydrogen atoms or those at least one are a cyano group, a nitro group, or a halogen atom.)

[Claim 15] Organic electroluminescence devices to which X in said general formula (1) is expressed with the following structure expression (18) and which were indicated to claim 1.

[Formula 16]

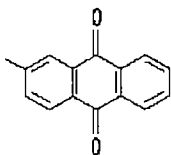
構造式 (18) :



[Claim 16] Organic electroluminescence devices to which X in said general formula (1) is expressed with the following structure expression (19) and which were indicated to claim 1.

[Formula 17]

構造式 (19) :



[Claim 17] Organic electroluminescence devices for which said organic layer has the organic laminated structure to which the laminating of an electron hole

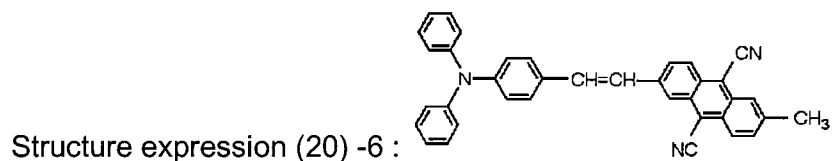
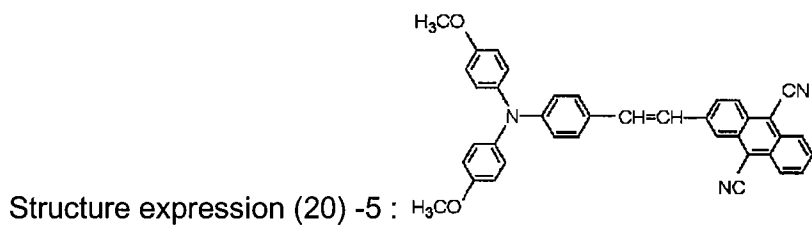
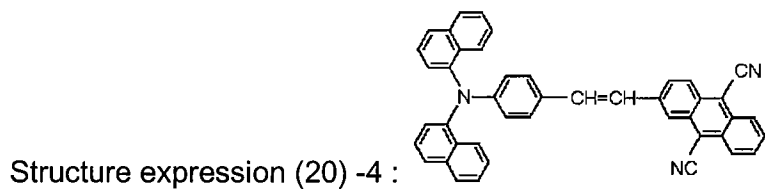
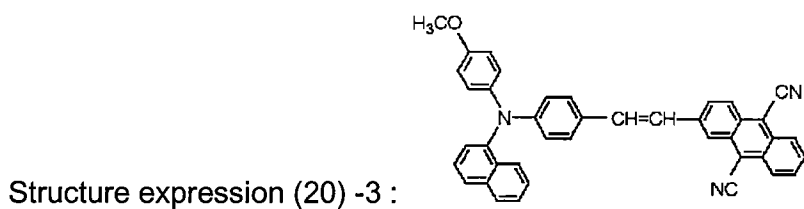
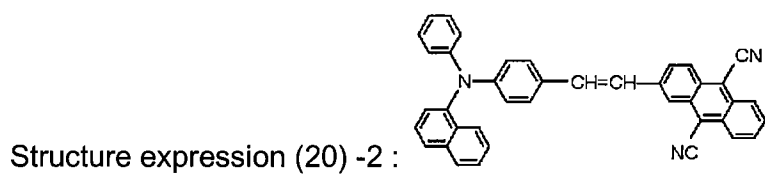
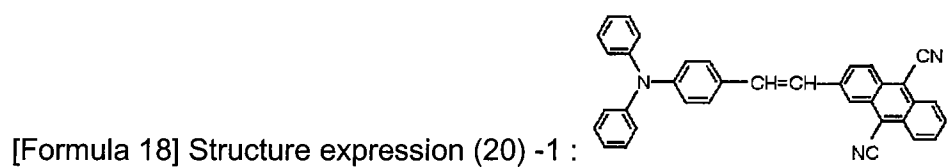
transportation layer and the electron transport layer was carried out, and said styryl compound is used as a formation ingredient of said electron hole transportation layer and which were indicated to claim 1.

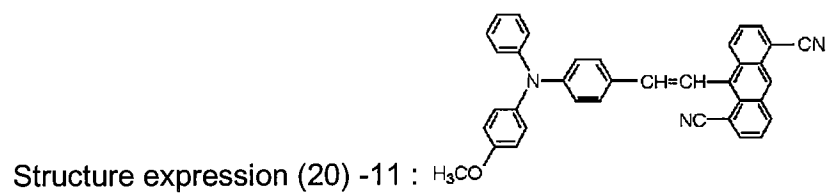
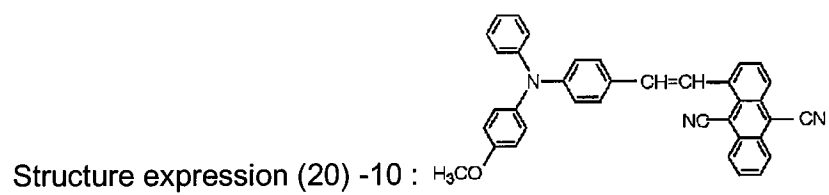
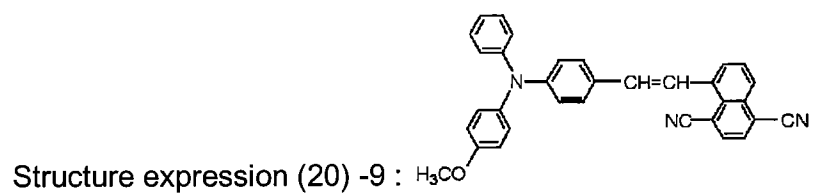
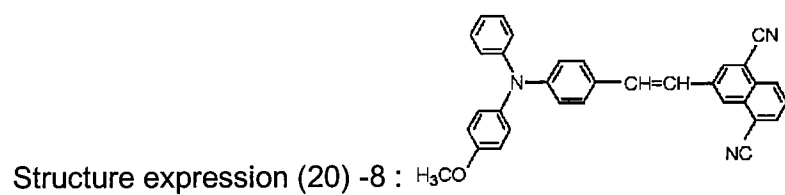
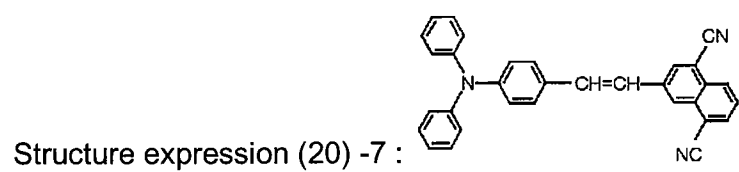
[Claim 18] Organic electroluminescence devices for which said organic layer has the organic laminated structure to which the laminating of an electron hole transportation layer and the electron transport layer was carried out one by one, and said styryl compound is used as a formation ingredient of said electron transport layer and which were indicated to claim 1.

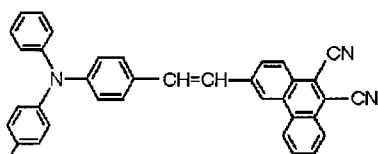
[Claim 19] Organic electroluminescence devices for which said organic layer has the organic laminated structure to which the laminating of an electron hole transportation layer, a luminous layer, and the electron transport layer was carried out, and said styryl compound is used as a formation ingredient of said luminous layer and which were indicated to claim 1.

[Claim 20] In the organic electroluminescence devices by which the organic layer which has a luminescence field is prepared between an anode plate and cathode To said organic layer, the following structure expression (20) -1, (20) -2, (20) -13, and -14 and (-3, (20)-4, and (20) -5 and (20) -6 and (20) -7 and (20) -8 and (20) -9 and (20) -10 and (20) -11 and (20) -12 and (20) 20 (20) (20) (20)- [ -15 and / -16 and ] 17 Or organic electroluminescence devices characterized by containing at least one sort of a styryl compound expressed with (20)-18 as an

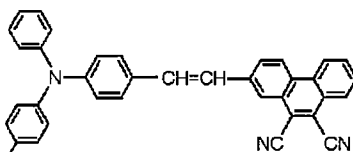
organic luminescent material.



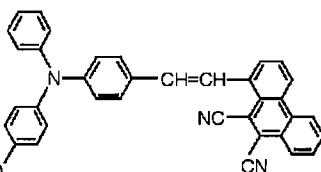




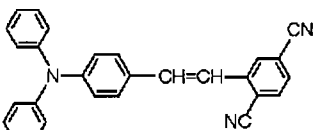
Structure expression (20) -12 : H<sub>3</sub>CO



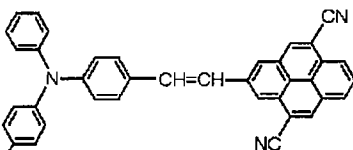
Structure expression (20) -13 : H<sub>3</sub>CO



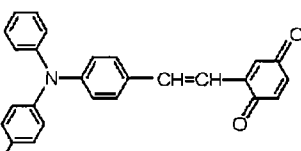
Structure expression (20) -14 : H<sub>3</sub>CO



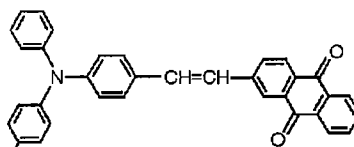
Structure expression (20) -15 : H<sub>3</sub>CO



Structure expression (20) -16 : H<sub>3</sub>CO



Structure expression (20) -17 : H<sub>3</sub>CO



Structure expression (20) -18 :  $\text{H}_3\text{CO}$

[Claim 21] Organic electroluminescence devices for which said organic layer has the organic laminated structure to which the laminating of an electron hole transportation layer and the electron transport layer was carried out, and said styryl compound is used as a formation ingredient of said electron hole transportation layer and which were indicated to claim 20.

[Claim 22] Organic electroluminescence devices for which said organic layer has the organic laminated structure to which the laminating of an electron hole transportation layer and the electron transport layer was carried out one by one, and said styryl compound is used as a formation ingredient of said electron transport layer and which were indicated to claim 20.

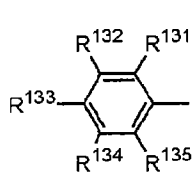
[Claim 23] Organic electroluminescence devices for which said organic layer has the organic laminated structure to which the laminating of an electron hole transportation layer, a luminous layer, and the electron transport layer was carried out, and said styryl compound is used as a formation ingredient of said luminous layer and which were indicated to claim 20.

[Claim 24] Organic electroluminescence devices characterized by a hole blocking layer existing in contact with the cathode side of the organic layer which consisted of amino styryl compounds in which at least one layer in said organic layer is shown by the following general formula [I] in the organic electroluminescence devices by which the organic layer which has a luminescence field is prepared between an anode plate and cathode, and consisted of said amino styryl compounds.

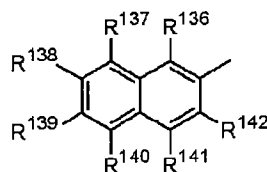


It is the radical as which X1 is expressed in following general formula (21) - (33)

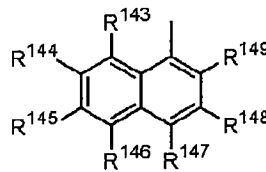
in [, however said general formula [I], and is [Formula 20].



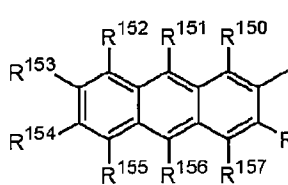
(21)



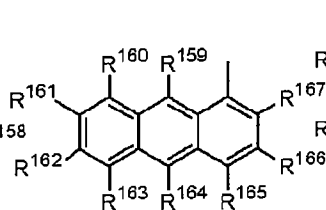
(22)



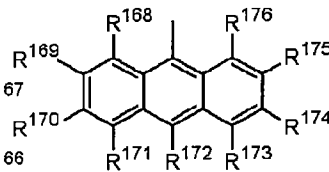
(23)



(24)

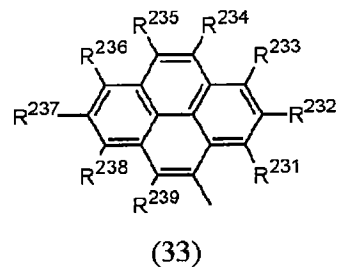
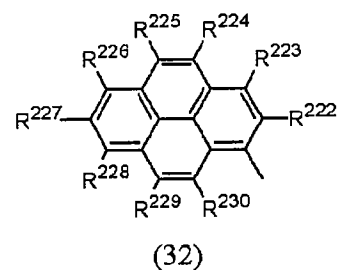
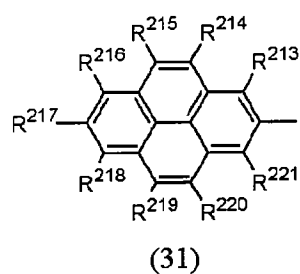
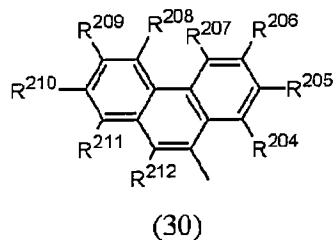
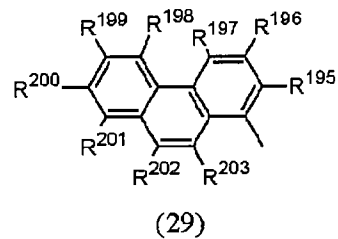
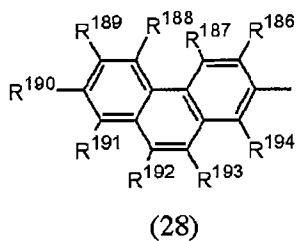
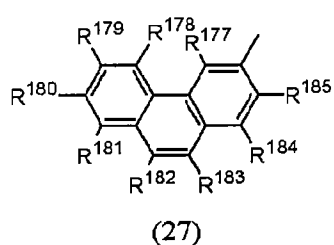


(25)



(26)

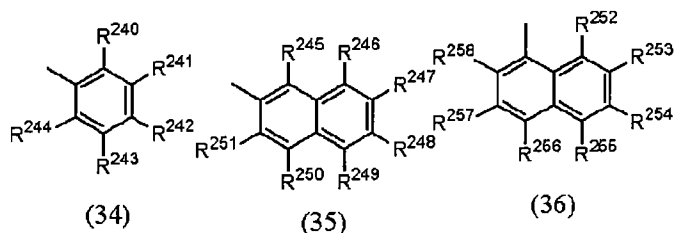




(However, in said general formula (21) - (33), R131-R239 are the radicals chosen from a hydrogen atom or the halogen atom, the nitro group, the cyano group, and the trifluoromethyl radical, and its they may be the same or they may differ.)

Moreover, Y1 and Y2 are the radicals chosen from the aryl group which may have a hydrogen atom, the alkyl group which may have a substituent, or the substituent expressed with following general formula (34) - (36), and its they may be the same or they may differ.

[Formula 21]



(However, in said general formula (34) - (36), R<sup>240</sup>-R<sup>258</sup> are the radicals chosen from a hydrogen atom, the alkyl group which may have a substituent, the aryl group which may have a substituent, the alkoxy group which may have a substituent, the halogen atom, the nitro group, the cyano group, and the trifluoromethyl radical, and its they may be the same or they may differ.)]

[Claim 25] Organic electroluminescence devices indicated to claim 24 in which said hole blocking layer exists in contact with the cathode side of the layer which said organic layer is having the organic laminated structure to which the laminating of a hole transportation layer and the electron transport layer was carried out, and consisted of amino styryl compounds of said organic layers in which an electron transport layer is shown by said general formula [I] at least, and consisted of said amino styryl compounds.

[Claim 26] Organic electroluminescence devices in which said hole blocking layer exists in contact with the cathode side of the layer which said organic layer is having the organic laminated structure to which the laminating of a hole

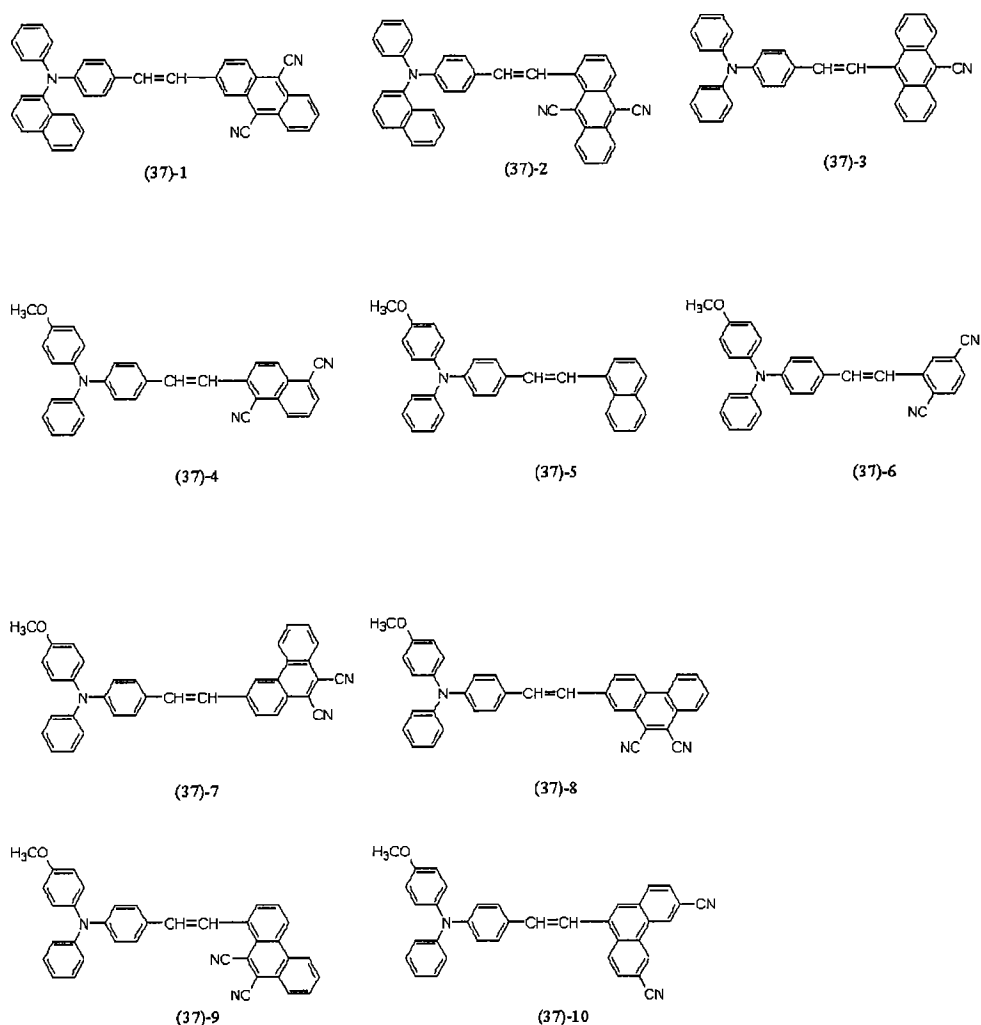
transportation layer and the electron transport layer was carried out, and consisted of amino styryl compounds of said organic layers in which a hole transportation layer is shown by said general formula [I] at least, and consisted of said amino styryl compounds and which were indicated to claim 24.

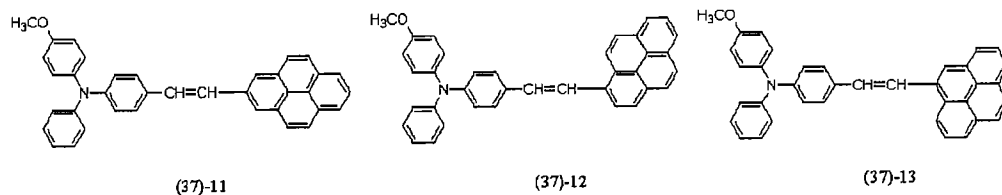
[Claim 27] Organic electroluminescence devices in which it consists of amino styryl compounds in which said organic layer is having the organic laminated structure to which the laminating of a hole transportation layer and the electron transport layer was carried out, and it consists of amino styryl compounds in which said hole transportation layer is shown by said general formula [I], and said electron transport layer is shown by said general formula [I], and said hole blocking layer exists in contact with the cathode side of the electronic transportability luminescence layer of a parenthesis and which were indicated to claim 24.

[Claim 28] Organic electroluminescence devices in which said hole blocking layer exists in contact with the cathode side of the layer which said organic layer is having the organic laminated structure to which the laminating of a hole transportation layer, a luminous layer, and the electron transport layer was carried out, and consisted of amino styryl compounds of said organic layers in which said luminous layer is shown by said general formula [I] at least, and consisted of said amino styryl compounds and which were indicated to claim 24.

[Claim 29] Organic electroluminescence devices characterized by a hole blocking layer existing in contact with the cathode side of the layer which consisted of amino styryl compounds in which at least one layer in said organic layer is shown by following structure-expression (37)-1-(37)-13 in the organic electroluminescence devices by which the organic layer which has a luminescence field is prepared between an anode plate and cathode, and consisted of said amino styryl compounds.

[Formula 22]





[Claim 30] Organic electroluminescence devices to which said hole blocking layer exists in a cathode side in contact with the layer which said organic layer is having the organic laminated structure to which the laminating of a hole transportation layer and the electron transport layer was carried out, and consisted of amino styryl compounds of said organic layers in which an electron transport layer is shown by said structure-expression (37)-1-(37)-13 at least, and consisted of said amino styryl compounds and which were indicated to claim 29.

[Claim 31] Organic electroluminescence devices to which said hole blocking layer exists in a cathode side in contact with the layer which said organic layer is having the organic laminated structure to which the laminating of a hole transportation layer and the electron transport layer was carried out, and consisted of amino styryl compounds of said organic layers in which a hole transportation layer is shown by said structure-expression (37)-1-(37)-13 at least, and consisted of said amino styryl compounds and which were indicated to claim 29.

[Claim 32] Said organic layer is having the organic laminated structure to which the laminating of a hole transportation layer and the electron transport layer was carried out. It consists of amino styryl compounds in which said hole transportation layer is shown by said structure-expression (37)-1-(37)-13. And organic electroluminescence devices in which it consists of amino styryl compounds in which said electron transport layer is shown by said structure-expression (37)-1-(37)-13, and said hole blocking layer exists in contact with the cathode side of said electronic transportability luminous layer and which were indicated to claim 29.

[Claim 33] Organic electroluminescence devices in which said hole blocking layer exists in contact with the cathode side of the layer which said organic layer is having the organic laminated structure to which the laminating of a hole transportation layer, a luminous layer, and the electron transport layer was carried out, and consisted of amino styryl compounds of said organic layers in which said luminous layer is shown by said structure-expression (37)-1-(37)-13 at least, and consisted of said amino styryl compounds and which were indicated to claim 29.

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## DETAILED DESCRIPTION

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[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to the organic electroluminescence devices (organic EL device) by which the organic layer which has a luminescence field is prepared between an anode plate and cathode.

[0002]

[Description of the Prior Art] The lightweight and efficient flat-panel display is briskly studied and developed as an object for the screen display of a computer or television.

[0003] first -- although brightness of the Braun tube (CRT) is high, and it is used most mostly as a current display since color reproduction nature is good -- \*\* -- it is high and power consumption also has heavily the problem of being high.

[0004] Moreover, liquid crystal displays, such as an active-matrix drive, are commercialized as a lightweight and efficient flat-panel display. However, the angle of visibility of a liquid crystal display is narrow, and since it is not spontaneous light, it has the trouble of not having sufficient response engine performance to that the power consumption of a back light is large, and the high-speed video signal of a high definition with which utilization will be expected

from now on under an environment dark in a perimeter. Technical problems, like especially the thing for which the display of big screen size is manufactured is difficult, and the cost is high also occur.

[0005] Although there is possibility of the display using the light emitting diode as an alternative over this, too, a manufacturing cost is high and the technical problem to utilization is large as a display candidate of a low price who there are problems, like it is difficult to form the matrix structure of a light emitting diode on the substrate whose number is one, and replaces the Braun tube.

[0006] Organic electroluminescence devices (organic EL device) using an organic luminescent material as a flat-panel display which may solve many of these technical problems attract attention recently. That is, by using an organic compound as a luminescent material, a speed of response is high-speed with spontaneous light, and implementation of a flat-panel display without an angle-of-visibility dependency is expected.

[0007] The configuration of organic electroluminescence devices forms the organic thin film containing the luminescent material which emits light by impregnation of a current between the positive electrode of translucency, and metal cathode. C. W.Tang, S.A.VanSlyke, etc. In the research report of the 51st-volume No. 12 Applied Physics Letters 913-915-page (1987) printing The component structure which emits light when the hole and electron which were



poured in into the organic film from each electrode recombine an organic thin film as two-layer structure of the thin film which consists of an electron hole transportability ingredient, and the thin film which consists of an electronic transportability ingredient was developed (organic EL device of single hetero structure).

[0008] With this component structure, either the electron hole transportation ingredient or the electronic transportation ingredient serves as luminescent material, and luminescence occurs by the wavelength range corresponding to the energy gap of the ground state and excitation state of luminescent material. By considering as such two-layer structure, reduction of large driver voltage and an improvement of luminous efficiency were made.

[0009] Then, C.Adachi, S.Tokita, T.Tsutsui, S.Saito etc. As indicated by the research report of Japanese Journal of Applied Physics volume [ 27th ] No. 2 L269-L 271-page (1988) printing The three-tiered structure (organic EL device of double hetero structure) of an electron hole transportation ingredient, luminescent material, and an electronic transportation ingredient is developed. Furthermore, C.W.Tang, S.A.VanSlyke, C.H.Chen, etc. Journal of Applied Physics As indicated by the research report of the 65th-volume No. 9 3610-3616-page (1989) printing The component structure where luminescent material was included in the electronic transportation ingredient etc. was

developed. By these researches, by the low battery, the possibility of luminescence of high brightness is verified and researches and developments are done very actively in recent years.

[0010] It can be said that there is an organic compound used for luminescent material about the advantage that the luminescent color is theoretically changeable into arbitration by changing the molecular structure from the versatility. Therefore, it can be said to be easy by performing a molecular design compared with the thin film EL element which used the inorganic substance to arrange three good colors of R (red), G (green), and B (blue) of color purity required for a full color display.

[0011]

[Problem(s) to be Solved by the Invention] However, also in organic electroluminescence devices, there is a problem which must be solved in fact.

As an electronic transportation ingredient by which is difficult for development of the stable red light emitting device of high brightness, and the current report is carried out tris (eight quinolinol) aluminum (the following, Alq3, and an abbreviated name --) the example (Chem.Funct.Dyes, Proc.Int.Symp., 2nd P.536 (1993), etc. -- also setting -- the highest brightness --) of red luminescence

which	doped	DCM	[a
4-dicyanomethylene-6-(p-dimethylaminostyryl)-2-methyl-4H-pyran]			The

satisfaction as a display ingredient of dependability does not go.

[0012] Moreover, T.Tsutsui and D.U.Kim Inorganic and Organic electroluminescence BSB-BCN reported at the meeting (1996 Berlin) is 1000 cd/m<sup>2</sup>. Although the above high brightness is realized, it cannot be said to be what has a perfect chromaticity as red which corresponds in full color.

[0013] The present condition is that implementation of stability and the high red light emitting device of color purity is furthermore desired by high brightness.

[0014] Moreover, in JP,7-188649,A (Japanese Patent Application No. No. 148798 [ six to ]), although it has proposed using a specific JISUCHIRIRU compound as an organic electroluminescence ingredient, the target luminescent color is blue and it is not an object for red. on the other hand, a hole and an electron join together efficiently in a luminous layer by [ of a hole and an electron / energy ] shutting up and making structure in the laminated structure of organic electroluminescence devices, and it is reported that pure luminescence original with high brightness and luminescent material can be obtained -- \*\*\*\* (JP,10-79297,A, JP,11-204258,A, JP,11-204264,A, JP,11-204259,A, etc.) -- the target luminescent color is blue too and is not an object for red.

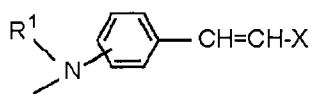
[0015] The purpose of this invention is to offer the organic electroluminescence devices which have high brightness and stable red luminescence. The second purpose of this invention promotes the hole in a luminous layer, and electronic

recombination in the organic electroluminescence devices containing the compound of this invention which has a quantum yield high originally, and is to offer the organic electroluminescence devices which present further high brightness and efficient luminescence.

[0016]

[Means for Solving the Problem] In order that this invention may solve the above-mentioned technical problem, as a result of inquiring wholeheartedly, a header and this invention are reached [ that the stable full color display implementation of high brightness can be provided with a red light emitting device with very useful high dependability, and ] by using a specific styryl compound as a luminescent material.

[0017] That is, this invention relates to the organic electroluminescence devices which the organic layer which has a luminescence field is prepared between an anode plate and cathode, and are characterized by containing at least one sort of the styryl compound of the unsymmetrical structure expressed with said organic layer by the following general formula (1) as an organic luminescent material in the organic electroluminescence devices which contain as a component the organic substance which emits light by impregnation of a current.



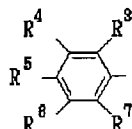
[Formula 23] General formula (1) :  $\text{R}^2$

[ -- however, said general formula (1) -- setting -- R1 and R2 -- mutual -- identitas

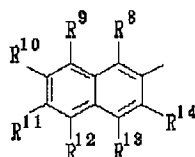
-- or the aryl group which is a different radical and is expressed with the following

general formula (2), (3), or (4) -- it is -- [Formula 24]

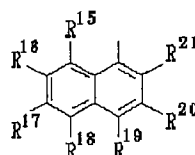
一般式 (2) :



一般式 (3) :



一般式 (4) :



said general formula (2), (3), and (4) -- setting -- R3 and R4 -- [ however, ] R5,

R6, R7, R8, R9, and R10, R11, R12, R13, R14, R15, R16, R17, R18, R19, R20

and R21 are radicals which are identitas mutually or are different. Hydrogen

atoms or those at least one Saturation or a partial saturation alkoxyl group (a

carbon number preferably 1-24, further thing of 1-10), they are an alkyl group (a

carbon number preferably 1-24, further thing of 1-10), the amino group, an

alkylamino radical (a carbon number preferably 1-24, further thing of 1-10), or an aryl group. X is the aryl group or hydrocarbon ring machine which is not permuted [ a permutation or ]. ]

[0018] While stable red luminescence is obtained by high brightness by using the styryl compound of the above-mentioned general formula (1) for luminescent material, the component which was chemically [ electrically, thermally, or ] excellent in stability can be offered. Although the styryl compound expressed with the above-mentioned general formula (1) can be used independently, respectively, you may use together.

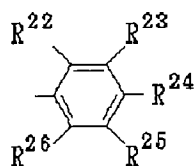
[0019]

[Embodiment of the Invention] In the styryl compound of the above-mentioned general formula (1) used for this invention, it is desirable that it is the radical expressed with following general formula (5) - (17) and structure-expression (18) - (19) as the above-mentioned X.

[0020]

[Formula 25]

一般式 (5) :

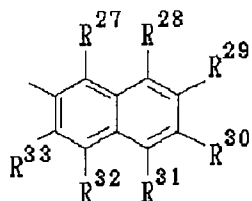


(However, in said general formula (5), R22, R23, R24, R25, and R26 are radicals which are identical mutually or are different, and those at least one is halogen (following, the same) atoms, such as a cyano group, a nitro group, or F, Cl, Br, I.)

[0021]

[Formula 26]

一般式 (6) :

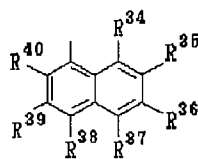


(However, in said general formula (6), R27, R28, R29, R30, R31, R32, and R33 are radicals which are identical mutually or are different, and hydrogen atoms or those at least one are a cyano group, a nitro group, or a halogen atom.)

[0022]

[Formula 27]

一般式 (7) :



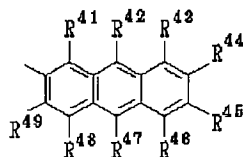
(However, in said general formula (7), R34, R35, R36, R37, R38, R39, and R40 are radicals which are identical mutually or are different, and hydrogen atoms or

those at least one are a cyano group, a nitro group, or a halogen atom.)

[0023]

[Formula 28]

一般式 (8) :

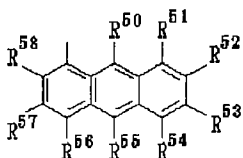


(However, in said general formula (8), R<sub>41</sub>, R<sub>42</sub>, R<sub>43</sub>, R<sub>44</sub>, R<sub>45</sub>, R<sub>46</sub>, R<sub>47</sub>, R<sub>48</sub>, and R<sub>49</sub> are radicals which are identical mutually or are different, and hydrogen atoms or those at least one are a cyano group, a nitro group, or a halogen atom.)

[0024]

[Formula 29]

一般式 (9) :



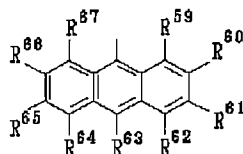
(However, in said general formula (9), R<sub>50</sub>, R<sub>51</sub>, R<sub>52</sub>, R<sub>53</sub>, R<sub>54</sub>, R<sub>55</sub>, R<sub>56</sub>, R<sub>57</sub>, and R<sub>58</sub> are radicals which are identical mutually or are different, and hydrogen atoms or those at least one are a cyano group, a nitro group, or a halogen atom.)

[0025]

[Formula 30]



一般式 (10) :

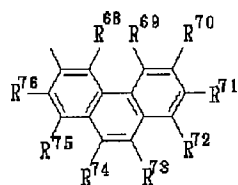


(However, in said general formula (10), R<sup>59</sup>, R<sup>60</sup>, R<sup>61</sup>, R<sup>62</sup>, R<sup>63</sup>, R<sup>64</sup>, R<sup>65</sup>, R<sup>66</sup>, and R<sup>67</sup> are radicals which are identical mutually or are different, and hydrogen atoms or those at least one are a cyano group, a nitro group, or a halogen atom.)

[0026]

[Formula 31]

一般式 (11) :

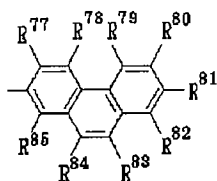


(However, in said general formula (11), R<sup>68</sup>, R<sup>69</sup>, R<sup>70</sup>, R<sup>71</sup>, R<sup>72</sup>, R<sup>73</sup>, R<sup>74</sup>, R<sup>75</sup>, and R<sup>76</sup> are radicals which are identical mutually or are different, and hydrogen atoms or those at least one are a cyano group, a nitro group, or a halogen atom.)

[0027]

[Formula 32]

一般式 (12) :

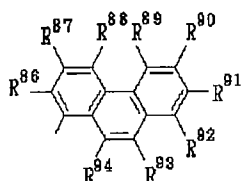


(However, in said general formula (12), R<sup>77</sup>, R<sup>78</sup>, R<sup>79</sup>, R<sup>80</sup>, R<sup>81</sup>, R<sup>82</sup>, R<sup>83</sup>, R<sup>84</sup>, and R<sup>85</sup> are radicals which are identical mutually or are different, and hydrogen atoms or those at least one are a cyano group, a nitro group, or a halogen atom.)

[0028]

[Formula 33]

一般式 (13) :

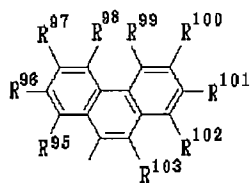


(However, in said general formula (13), R<sup>86</sup>, R<sup>87</sup>, R<sup>88</sup>, R<sup>89</sup>, R<sup>90</sup>, R<sup>91</sup>, R<sup>92</sup>, R<sup>93</sup>, and R<sup>94</sup> are radicals which are identical mutually or are different, and hydrogen atoms or those at least one are a cyano group, a nitro group, or a halogen atom.)

[0029]

[Formula 34]

一般式 (14) :

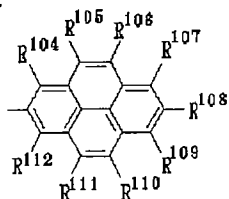


(However, in said general formula (14), R<sup>95</sup>, R<sup>96</sup>, R<sup>97</sup>, R<sup>98</sup>, R<sup>99</sup>, R<sup>100</sup>, R<sup>101</sup>, R<sup>102</sup>, and R<sup>103</sup> are radicals which are identical mutually or are different, and hydrogen atoms or those at least one are a cyano group, a nitro group, or a halogen atom.)

[0030]

[Formula 35]

一般式 (15) :

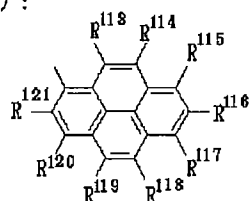


(However, in said general formula (15), R<sup>104</sup>, R<sup>105</sup>, R<sup>106</sup>, R<sup>107</sup>, R<sup>108</sup>, R<sup>109</sup>, R<sup>110</sup>, R<sup>111</sup>, and R<sup>112</sup> are radicals which are identical mutually or are different, and hydrogen atoms or those at least one are a cyano group, a nitro group, or a halogen atom.)

[0031]

[Formula 36]

一般式 (16) :

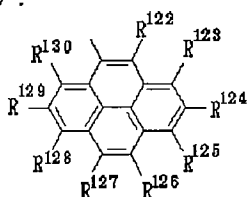


(However, in said general formula (16), R<sup>113</sup>, R<sup>114</sup>, R<sup>115</sup>, R<sup>116</sup>, R<sup>117</sup>, R<sup>118</sup>, R<sup>119</sup>, R<sup>120</sup>, and R<sup>121</sup> are radicals which are identical mutually or are different, and hydrogen atoms or those at least one are a cyano group, a nitro group, or a halogen atom.)

[0032]

[Formula 37]

一般式 (17) :

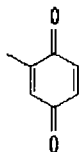


(However, in said general formula (17), R<sup>122</sup>, R<sup>123</sup>, R<sup>124</sup>, R<sup>125</sup>, R<sup>126</sup>, R<sup>127</sup>, R<sup>128</sup>, R<sup>129</sup>, and R<sup>130</sup> are radicals which are identical mutually or are different, and hydrogen atoms or those at least one are a cyano group, a nitro group, or a halogen atom.)

[0033]

[Formula 38]

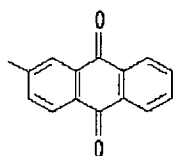
構造式 (18) :



[0034]

[Formula 39]

構造式 (19) :



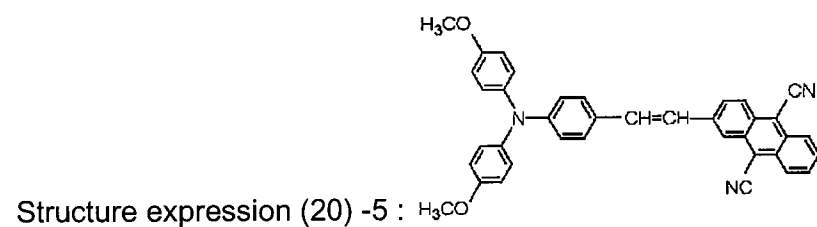
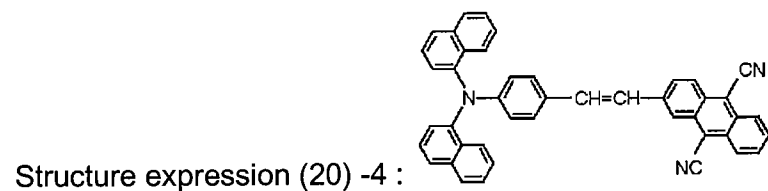
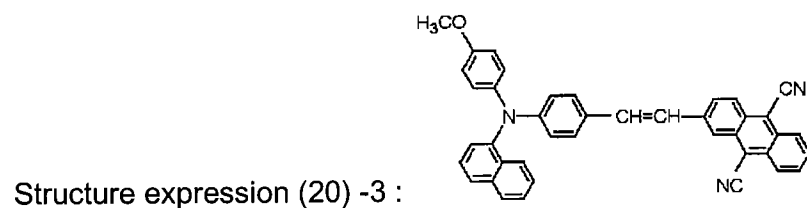
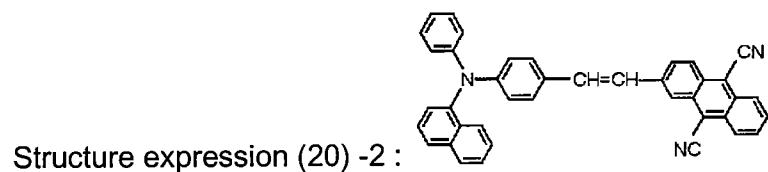
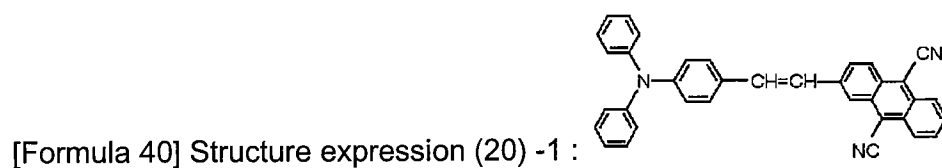
[0035] although such X is important when the luminescent material used for this invention produces red luminescence, the number of the benzene rings increases, for example -- alike -- following -- the luminescence wavelength of an organic luminescent material -- a long wave -- there is an inclination shifted to a merit side. Moreover, luminescence of luminescent material is red luminescence like [ X / the above-mentioned structure expression (18) and / of (19) ] the thing of other general formulas.

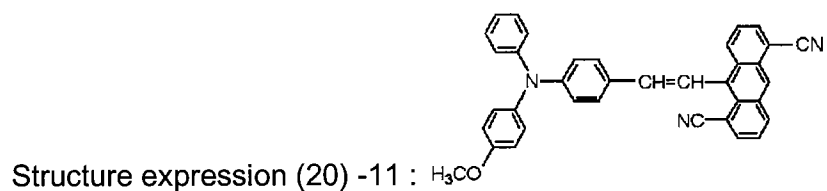
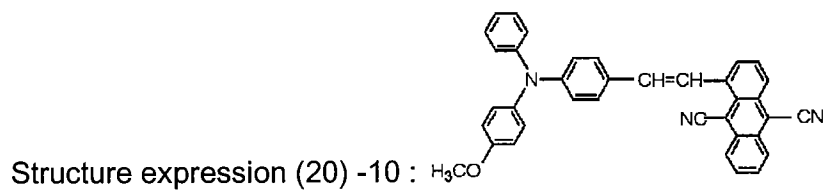
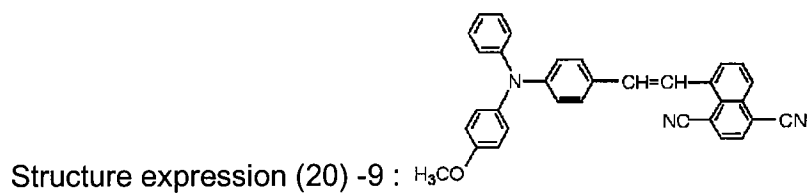
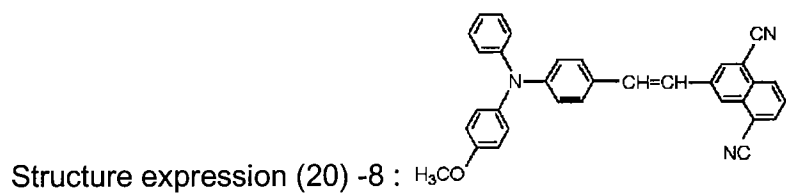
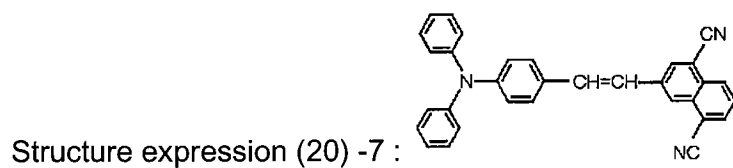
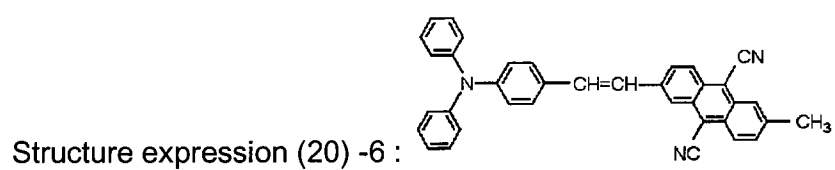
[0036] In the organic electroluminescence devices of this invention, the styryl compound shown by the general formula (1) which is luminescent material For example, the following structure expression (20) -1, (20) -2, (20) -13, and -14 and (-3, (20)-4, and (20) -5 and (20) -6 and (20) -7 and (20) -8 and (20) -9 and

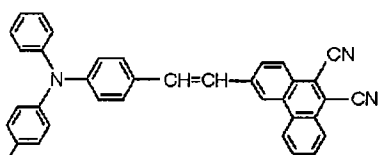
(20) -10 and (20) -11 and (20) -12 and (20) 20 (20) (20) (20)- [ -15 and / -16  
and ] 17 Or at least one sort of the molecular structure like (20)-18 is usable.

Each of these is 4-diaryl amino-styryl system compounds.

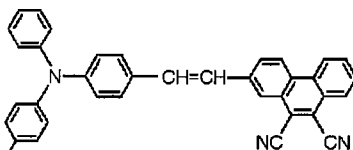
[0037]



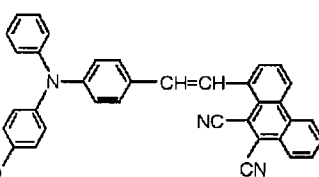




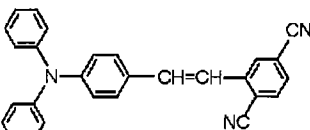
Structure expression (20) -12 : H<sub>3</sub>CO



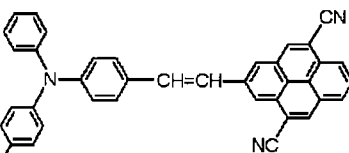
Structure expression (20) -13 : H<sub>3</sub>CO



Structure expression (20) -14 : H<sub>3</sub>CO

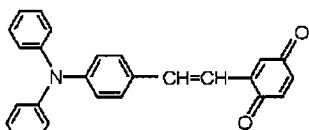


Structure expression (20) -15 : H<sub>3</sub>CO

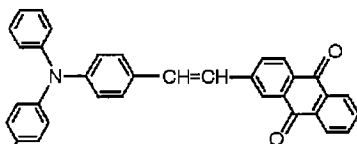


Structure expression (20) -16 : H<sub>3</sub>CO





Structure expression (20) -17 : COc1ccc(cc1)N(c2ccccc2)c3ccc(cc3)/C=C/c4ccc(cc4)C(=O)C(=O)c5ccccc5



Structure expression (20) -18 : COc1ccc(cc1)N(c2ccccc2)c3ccc(cc3)/C=C/c4c5c6ccccc6c(=O)c7ccccc7c(=O)c5cc4

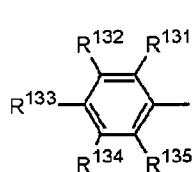
[0038] In order to solve the above-mentioned technical problem, as a result of inquiring wholeheartedly again, this invention person used to produce the organic electroluminescence devices which constituted the luminous layer from a specific styryl compound and an ingredient which can transmit energy to it efficiently, and used to reach this invention which offers the red light emitting device of high brightness and high-reliability further.

[0039] That is, the organic layer which has a luminescence field is prepared between an anode plate and cathode, and this invention requires at least one layer in said organic layer for the organic electroluminescence devices characterized by being the layer which consists of an amino styryl compound shown by the following general formula [I] in the organic electroluminescence devices which contain as a component the organic substance which emits light by impregnation of a current.

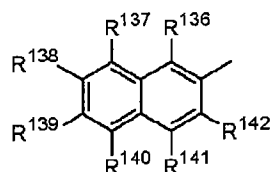


It is the radical as which X1 is expressed in following general formula (21) - (33)

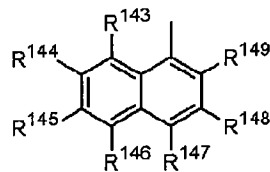
in [, however said general formula [I], and is [Formula 42].



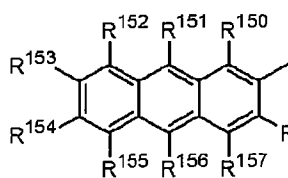
(21)



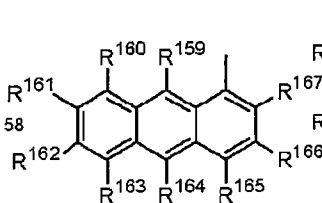
(22)



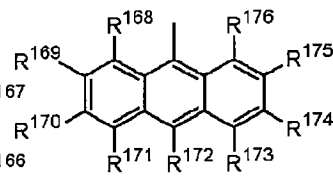
(23)



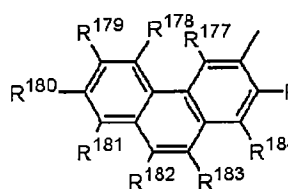
(24)



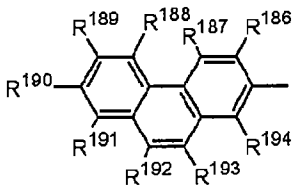
(25)



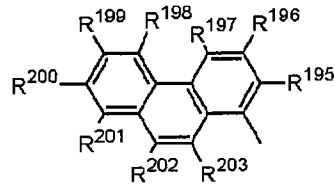
(26)



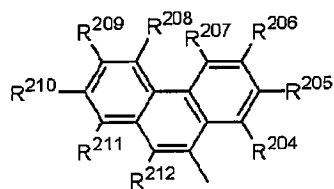
(27)



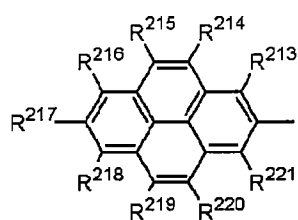
(28)



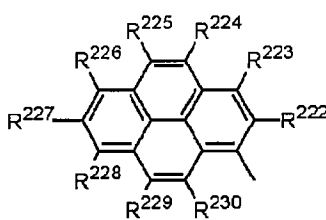
(29)



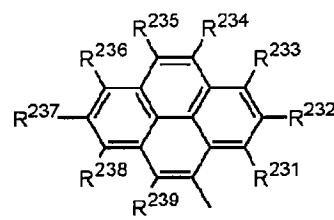
(30)



(31)



(32)

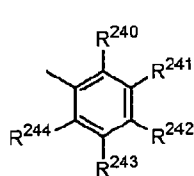


(33)

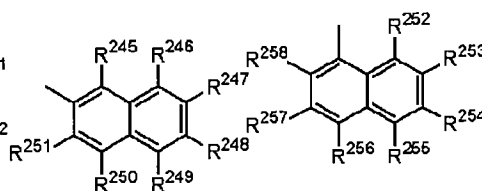
(However, in said general formula (21) - (33), R131-R239 are the radicals chosen from a hydrogen atom or the halogen atom, the nitro group, the cyano group, and the trifluoromethyl radical, and its they may be the same or they may differ.)

Moreover, Y1 and Y2 are the radicals chosen from the aryl group which may have a hydrogen atom, the alkyl group which may have a substituent, or the substituent expressed with following general formula (34) - (36), and its they may be the same or they may differ.

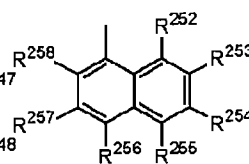
[Formula 43]



(34)



(35)



(36)

(However, in said general formula (34) - (36), R240-R258 are the radicals chosen from a hydrogen atom, the alkyl group which may have a substituent, the aryl group which may have a substituent, the alkoxy group which may have a

substituent, the halogen atom, the nitro group, the cyano group, and the trifluoromethyl radical, and its they may be the same or they may differ.))]

[0040] Moreover, in the organic electroluminescence devices containing the compound of above-mentioned this invention which has a quantum yield high originally, by putting a hole (electron hole) blocking layer on the cathode side of a luminous layer, recombination of a hole and an electron is efficiently performed in a luminous layer, and this invention comes to offer the organic electroluminescence devices from which pure luminescence original with luminescent material is obtained high brightness and efficient.

[0041] That is, this invention relates to the organic electroluminescence devices to which a hole blocking layer exists in the cathode side of the organic layer which consists of an amino styryl compound in which at least one layer of said organic layer is shown by said general formula [I], and contains said amino styryl compound in the organic electroluminescence devices by which the organic layer which has a luminescence field is prepared between an anode plate and cathode again.

[0042] For example, in contact with the cathode side of the layer which said organic layer is having the organic laminated structure to which the laminating of a hole transportation layer and the electron transport layer was carried out, and consisted of amino styryl compounds of said organic layers in which an electron

transport layer is shown by said general formula [I] at least, and consisted of said amino styryl compounds, said hole (electron hole) blocking layer may exist.

[0043] Moreover, said hole blocking layer may exist in contact with the cathode side of the layer which said organic layer is having the organic laminated structure to which the laminating of a hole transportation layer and the electron transport layer was carried out, and consisted of amino styryl compounds of said organic layers in which a hole transportation layer is shown by said general formula [I] at least, and consisted of said amino styryl compounds.

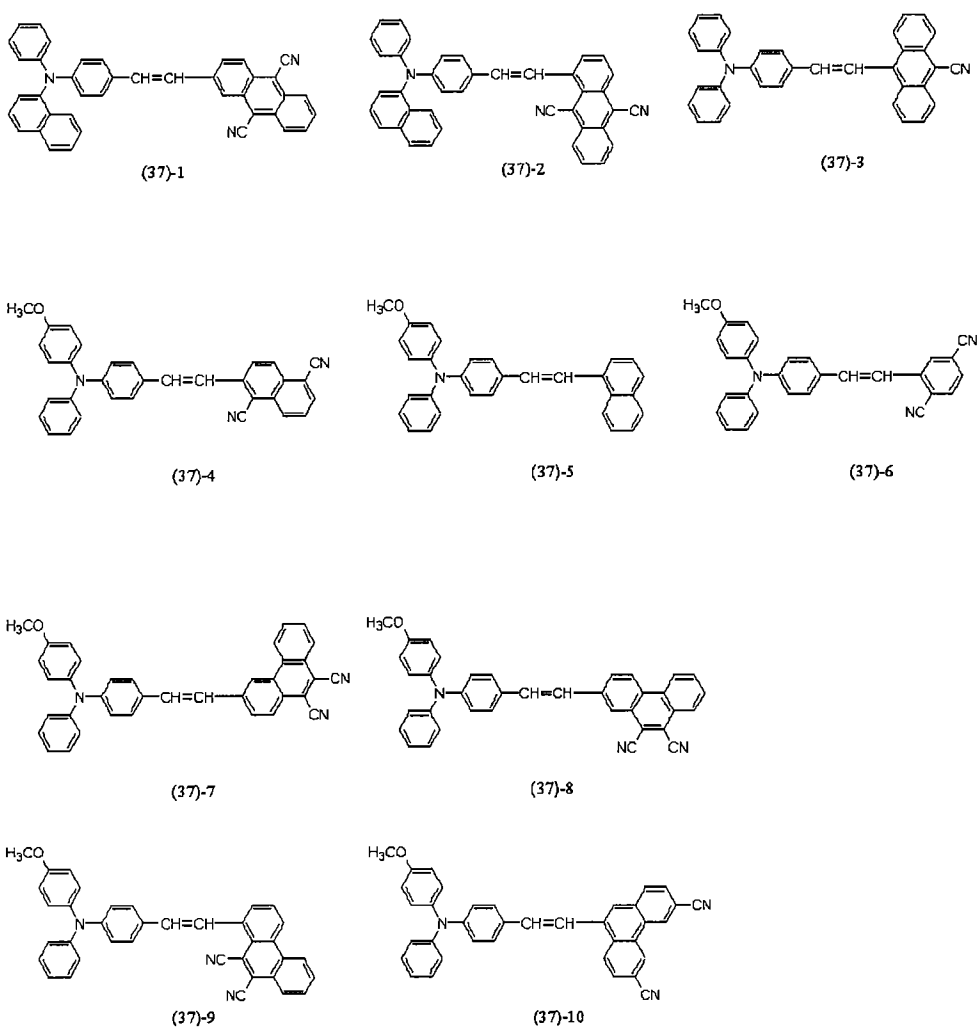
[0044] Moreover, it consists of amino styryl compounds in which said organic layer is having the organic laminated structure to which the laminating of a hole transportation layer and the electron transport layer was carried out, and it consists of amino styryl compounds in which said hole transportation layer is shown by said general formula [I], and said electron transport layer is shown by said general formula [I], and said hole blocking layer may exist in contact with the cathode side of the electronic transportability luminescence layer of a parenthesis.

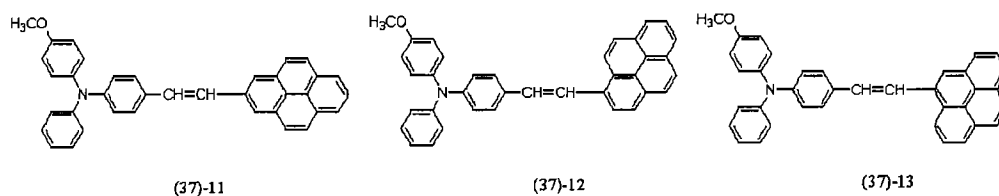
[0045] Moreover, said hole blocking layer may exist in contact with the cathode side of the layer which said organic layer is having the organic laminated structure to which the laminating of a hole transportation layer, a luminous layer, and the electron transport layer was carried out, and consisted of amino styryl

compounds of said organic layers in which a luminous layer is shown by said general formula [I] at least, and consisted of said amino styryl compounds.

[0046] In the organic electroluminescence devices of this invention, even if there is little molecular structure like following structure-expression (37)-1-(37)-13 as an amino styryl compound shown by the general formula [I], a kind is usable.

[Formula 44]





[0047] Moreover, it is desirable for the ingredient suitable for a hole blocking layer to be what has the following energy states. That is, be in energy level with the highest occupancy molecular-orbital level of the ingredient which forms a hole blocking layer lower than the highest occupancy molecular-orbital level of the ingredient which forms the layer which touches the anode plate side of a hole blocking layer. in addition -- and it is being in energy level lower than the minimum non-occupying molecular-orbital level of the ingredient which forms the layer which is in energy level with the minimum non-occupying molecular-orbital level of the ingredient which forms a hole blocking layer higher than the minimum non-occupying molecular-orbital level of the ingredient which forms the layer which touches the anode plate side of a hole blocking layer, and touches the cathode side of a hole blocking layer.

[0048] Although the phenanthroline derivative shown in JP,10-79297,A, JP,11-204258,A, JP,11-204264,A, JP,11-204259,A, etc. is mentioned as such an ingredient, if the conditions of the above-mentioned energy level are fulfilled, it will not be limited to a phenanthroline derivative.

[0049] Drawing 1 - drawing 4 and drawing 5 - drawing 8 show the example of organic electroluminescence devices based on this invention, respectively.

[0050] Drawing 1 is the transparency mold organic electroluminescence devices A to which the luminescence light 20 penetrates cathode 3, and luminescence 20 can be observed also from a protective layer 4 side. Drawing 2 shows the reflective mold organic electroluminescence devices B which also obtain the reflected light in cathode 3 as a luminescence light 20.

[0051] Among drawing, one is a substrate for forming organic electroluminescence devices, and can use glass, plastics, and other proper ingredients. Moreover, a substrate can also be shared when using organic electroluminescence devices combining other display devices. 2 -- a transparent electrode (anode plate) -- it is -- ITO (Indium tin oxide) and SnO<sub>2</sub> etc. -- it can be used.

[0052] Moreover, 5 is an organic luminous layer and contains the above-mentioned styryl compound as a luminescent material. About this luminous layer, well-known various configurations can be conventionally used as lamination which obtains organic electroluminescence 20. When the ingredient which constitutes an electron hole transportation layer or an electron transport layer has a luminescence so that it may mention later for example, the structure which carried out the laminating of these thin films can be used. Furthermore, in



order to raise charge transportability ability in the range which fills the purpose of this invention, both an electron hole transportation layer, and both [ either or ] bar using the structure which carried out the laminating of the thin film of two or more sorts of ingredients, or the thin film which consists of a presentation which mixed two or more sorts of ingredients. Moreover, in order to improve the luminescence engine performance, the ingredient of at least one or more sorts of fluorescence may be used, and the structure which pinched this thin film between the electron hole transportation layer and the electron transport layer, and the structure where the ingredient of at least one or more sorts of fluorescence was further included in an electron hole transportation layer, electron transport layers, or these both may be used. In order to improve luminous efficiency in these cases, it is also possible to include the thin film for controlling transportation of an electron hole or an electron in the lamination.

[0053] For example, since the styryl compound illustrated with the above-mentioned structure expression (20) has both electronic transportability ability and electron hole transportability ability, it can be used during a component configuration also as a luminous layer which served as the electron hole transportation layer also as a luminous layer which served both as the electron transport layer. Moreover, it is also possible to consider as the configuration put in the electron transport layer and the electron hole

transportation layer by making this styryl compound into a luminous layer. In addition to the above-mentioned configuration, drawing 5 and drawing 6 form the hole blocking layer 21 which consists of a phenanthroline derivative in contact with the cathode side of a luminous layer 5.

[0054] In addition, among drawing 1 and drawing 2 , drawing 5 , and drawing 6 , three are cathode and can use the alloy of a metal [ activity / calcium / Li, Mg, ] and metals, such as Ag, aluminum, and In, or the structure which carried out the laminating of these as an electrode material. In the organic electroluminescence devices of a transparency mold, the light transmittance suitable for an application can be obtained by adjusting the thickness of cathode. Moreover, four in drawing is the closure and a protective layer, and the effectiveness goes up it by making the organic whole electroluminescence devices into wrap structure. A proper ingredient can be used if airtightness is maintained. Moreover, 8 is a drive power source for current impregnation.

[0055] In the organic electroluminescence devices based on this invention, the organic layer has the organic laminated structure (single hetero structure) to which the laminating of an electron hole transportation layer and the electron transport layer was carried out, and said styryl compound may be used as a formation ingredient of an electron hole transportation layer or an electron transport layer. Or the organic layer has the organic laminated structure (double

hetero structure) to which the laminating of an electron hole transportation layer, a luminous layer, and the electron transport layer was carried out one by one, and said styryl compound may be used as a formation ingredient of a luminous layer.

[0056] When the example of the organic electroluminescence devices which have such an organic laminated structure is shown, drawing 3 has the laminated structure to which the laminating of organic layer 5a which consists of an anode plate 2, and the electron hole transportation layer 6 and electron transport layer 7 of translucency on the substrate 1 of translucency, and the cathode 3 was carried out one by one, and is the organic electroluminescence devices C of the single hetero structure where a protective coat 4 comes to carry out the closure of this laminated structure. In drawing 7, the hole blocking layer 21 is formed in contact with the cathode side of an electron transport layer 7 and/or the electron hole transportation layer 6.

[0057] In the case of the lamination which omitted the luminous layer as shown in drawing 3 and drawing 7, the luminescence 20 of predetermined wavelength is generated from the interface of the electron hole transportation layer 6 and an electron transport layer 7. These luminescence is observed from a substrate 1 side.

[0058] Moreover, drawing 4 has the laminated structure to which the laminating

of organic layer 5b which consists of an anode plate 2, and the electron hole transportation layer 10, the luminous layer 11 and electron transport layer 12 of translucency on the substrate 1 of translucency, and the cathode 3 was carried out one by one, and is the organic electroluminescence devices D of the double hetero structure where a protective coat 4 comes to carry out the closure of this laminated structure. In drawing 8 , the hole blocking layer 21 is formed in contact with the cathode side of a luminous layer 11.

[0059] In the organic electroluminescence devices shown in drawing 4 , the electron with which the electron hole poured in from the anode plate 2 was poured in from cathode 3 through the electron hole transportation layer 10 reaches a luminous layer 11 through an electron transport layer 12, respectively by impressing direct current voltage between an anode plate 2 and cathode 3. Consequently, the recombination of an electron/electron hole arises in a luminous layer 11, a singlet exciton generates, and luminescence of predetermined wavelength is generated from this singlet exciton.

[0060] In each organic electroluminescence devices C and D mentioned above, the ingredient of light transmission nature, such as glass and plastics, can be suitably used for a substrate 1. Moreover, when using combining other display devices, or when arranging the laminated structure shown in drawing 3 and drawing 4 , drawing 7 , and drawing 8 in the shape of a matrix, it is good

considering this substrate as common use. Moreover, Components C and D can all take any structure of a transparency mold and a reflective mold.

[0061] moreover, the anode plate 2 -- a transparent electrode -- it is -- ITO (indium tin oxide) and SnO<sub>2</sub> etc. -- it can be used. Between this anode plate 2 and the electron hole transportation layer 6 (or electron hole transportation layer 10), the thin film which consists of the organic substance or an organometallic compound may be prepared in order to improve the injection efficiency of a charge. In addition, when the protective coat 4 is formed with conductive ingredients, such as a metal, the insulator layer may be prepared in the side face of an anode plate 2.

[0062] Moreover, the electron hole transportation layer 6 and an electron transport layer 7 are organic layers by which the laminating was carried out, the styryl compound described above to these either or both sides contains organic layer 5a in the organic electroluminescence devices C, and it is good as the luminescent electron hole transportation layer 6 or a luminescent electron transport layer 7. Organic layer 5b in the organic electroluminescence devices D can take various laminated structures, although the electron hole transportation layer 10, the luminous layer 11 containing the above-mentioned styryl compound, and an electron transport layer 12 are organic layers by which the laminating was carried out. For example, both the electron hole transportation layer, and

both [ either or ] may have a luminescence.

[0063] Moreover, although it is desirable that it is the layer which the electron hole transportation layer 6 or an electron transport layer 7, and a luminous layer 11 turn into from said styryl compound especially, these layers may be formed only with said styryl compound, or you may form by said styryl compound, other electron holes, or vapor codeposition with electronic transportation ingredients (for example, aromatic amine and pyrazolines etc.). Furthermore, in an electron hole transportation layer, in order to raise electron hole transportability ability, the electron hole transportation layer which carried out the laminating of two or more sorts of electron hole transportation ingredients may be formed.

[0064] Moreover, in the organic electroluminescence devices C, although a luminous layer may be the electronic transportability luminous layer 7, depending on the electrical potential difference impressed from a power source 8, light may be emitted by the electron hole transportation layer 6 or its interface. Similarly, in the organic electroluminescence devices D, a luminous layer may be an electron transport layer 12 in addition to layer 11, and may be the electron hole transportation layer 10. In order to raise the luminescence engine performance, it is good that it is the structure where the luminous layer 11 which used at least one sort of fluorescence ingredients was made to pinch between an electron hole transportation layer and an electron transport layer. Or the

structure where an electron hole transportation layer, an electron transport layer, or both [ these ] layers were made to contain this fluorescence ingredient may be constituted. In such a case, in order to improve luminous efficiency, it is also possible to include the thin films (a hole blocking layer, exciton generation layer, etc.) for controlling transportation of an electron hole or an electron in the lamination.

[0065] Moreover, you may be the structure in which could use the alloy of a metal [ activity / calcium / Li, Mg, ] and metals, such as Ag, aluminum, and In, as an ingredient used for cathode 3, and these metal layers carried out the laminating. In addition, the organic electroluminescence devices corresponding to an application are producible by choosing the thickness and the quality of the material of cathode suitably.

[0066] Moreover, a protective coat 4 acts as closure film, is making the organic whole electroluminescence devices into wrap structure, and can improve charge injection efficiency and luminous efficiency. In addition, if the airtightness is maintained, a single metal or alloys, such as aluminum, gold, and chromium, etc. can choose the ingredient suitably.

[0067] Although the current impressed to each above-mentioned organic electroluminescence devices is usually a direct current, pulse current and an alternating current may be used. If a current value and an

electrical-potential-difference value are within the limits which does not carry out component destruction, there will be especially no limit, but when the power consumption and the life of organic electroluminescence devices are taken into consideration, it is desirable to make light emit efficiently with as small electrical energy as possible.

[0068] Next, drawing 9 is the example of a configuration of the flat-surface display which used the organic electroluminescence devices of this invention. In the full color display, like illustration, red (R) and the green organic layer 5 (5a, 5b) which can emit light in the three primary colors of (G) and blue (B) are allotted between cathode 3 and an anode plate 2. It can prepare in the shape of [ which crosses mutually ] a stripe, it is chosen by the luminance-signal circuit 14 and the control circuit 15 with a built-in shift register, and a signal level is impressed to each, and cathode 3 and an anode plate 2 are constituted so that the organic layer of the location (pixel) where the cathode 3 and the anode plate 2 which were chosen by this cross may emit light.

[0069] That is, it is a 8x3RGB simple matrix, and drawing 9 arranges the layered product 5 which consists of one side between cathode 3 and an anode plate 2, even if there are few electron hole transportation layers, and luminous layers and electron transport layers either (refer to drawing 3 and drawing 7 or drawing 4 , and drawing 8 ). Both cathode and an anode plate are made to intersect



perpendicularly in the shape of a matrix mutually, impress a signal level serially by the control circuits 15 and 14 with a built-in shift register, and they are constituted so that light may be emitted in the decussation location, while carrying out patterning to the shape of a stripe. Of course, the EL element of this configuration can be used also as picture reproducer as a display of an alphabetic character, a notation, etc. Moreover, the stripe-like pattern of cathode 3 and an anode plate 2 is arranged for every color of red (R), green (G), and blue (B), and it becomes possible to constitute multicolor or all full color solid-state mold flat-panel displays.

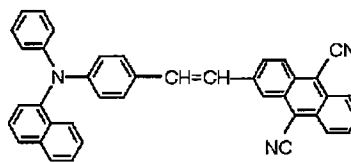
[0070]

[Example] Hereafter, although this invention is concretely explained about an example, this invention is not limited to the following examples.

[0071] Example 1 this example is R1 among the styryl compounds of a general formula (1). A non-permuted phenyl group and R2 It is the example which produced the organic electroluminescence devices of single hetero structure, using the compound of following structure-expression (20)-2 which had 9 and 10-dicyano anthracene radical in a non-permuted naphthyl group and X as an electron hole transportability luminescent material.

[0072]

[Formula 45] Structure expression (20) -2 :



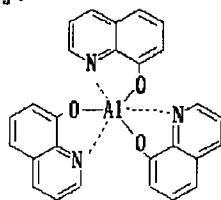
[0073] First, the 30mmx30mm glass substrate with which the anode plate which consists of ITO with a thickness of 100nm was formed on one front face into the vacuum evaporation system was set. The substrate was approached, the metal mask which has two or more 2.0mmx2.0mm unit openings as a vacuum evaporation mask has been arranged, and the compound of above-mentioned structure-expression (20)-2 was formed as an electron hole transportation layer (\*\*\*\*\*) in thickness of 50nm under the vacuum of  $10^{-4}$  or less Pa with the vacuum deposition method. The vacuum evaporation rate was carried out in 0.1nm/second.

[0074] Furthermore, Alq3 (tris (eight quinolinol) aluminum) of the following structure expression was vapor-deposited in contact with the electron hole transportation layer as an electronic transportation ingredient. Alq3 from -- thickness of this becoming electron transport layer was also set to 50nm, and the vacuum evaporation rate was carried out in 0.2nm/second.

[0075]

[Formula 46]

Alq<sub>3</sub> :



[0076] The cascade screen of Mg and Ag was adopted as a cathode material, and by vacuum evaporation, this was also formed in the thickness of 50nm (Mg film) and 150nm (Ag film) as vacuum evaporation rate 1nm/a second, and produced the \*\*\*\* organic electroluminescence devices shown in drawing 3 by the example 1.

[0077] Thus, forward bias direct current voltage was applied to the organic electroluminescence devices of the produced example 1 under nitrogen-gas-atmosphere mind, and the luminescence property was evaluated. The luminescent color was red, and as a result of performing spectrometry, as shown in drawing 10 , it obtained the spectrum which has a luminescence peak in 710nm. The spectroscopy which used the photodiode array by the Otsuka electronic company as the detector was used for spectrometry. Moreover, when the electrical-potential-difference-measurement of luminance is performed, as it is shown in drawing 11 , they are 1000 cd/m<sup>2</sup> at 8V. Brightness was obtained.

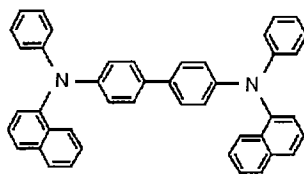
[0078] After producing these organic electroluminescence devices, although it was left for one month under nitrogen-gas-atmosphere mind, component

degradation was not observed. Moreover, initial brightness 300 cd/m<sup>2</sup> The current value was energized uniformly and continuation luminescence was carried out, and when carrying out forcible degradation, it was 900 hours until brightness was halved.

[0079] Example 2 this example is R1 among the styryl compounds of a general formula (1). A non-permuted phenyl group and R2 It is the example which produced the organic electroluminescence devices of single hetero structure, using the compound of above-mentioned structure-expression (20)-2 which had 9 and 10-dicyano anthracene radical in a non-permuted naphthyl group and X as an electronic transportability luminescent material.

[0080] First, the 30mmx30mm glass substrate with which the anode plate which consists of ITO with a thickness of 100nm was formed on one front face into the vacuum evaporation system was set. The substrate was approached, the metal mask which has two or more 2.0mmx2.0mm unit openings as a vacuum evaporation mask has been arranged, and alpha-NPD (alpha-naphthylphenyl diamine) of the following structure expression was formed as an electron hole transportation layer in thickness of 50nm under the vacuum of 10<sup>-4</sup> or less Pa with vacuum evaporation technique. The vacuum evaporation rate was carried out in 0.1nm/second.

[0081]



[Formula 47] Alpha-NPD

[0082] Furthermore, the compound of above-mentioned structure-expression (20)-2 was vapor-deposited in contact with the electron hole transportation layer as an electronic transportation ingredient. The above-mentioned structure expression (20) Thickness of the electron transport layer (\*\*\*\*\*) which consists of a compound of -2 was also set to 50nm, and the vacuum evaporation rate was carried out in 0.2nm/second.

[0083] The cascade screen of Mg and Ag was adopted as a cathode material, and by vacuum evaporation, this was also formed in the thickness of 50nm (Mg film) and 150nm (Ag film) as vacuum evaporation rate 1nm/a second, and produced the \*\*\*\* organic electroluminescence devices shown in drawing 3 by the example 2.

[0084] Thus, forward bias direct current voltage was applied to the organic electroluminescence devices of the produced example 2 under nitrogen-gas-atmosphere mind, and the luminescence property was evaluated. The luminescent color was red, and as a result of performing spectrometry like an example 1, as shown in drawing 12 , it obtained the spectrum which has a luminescence peak in 710nm. Moreover, when the

electrical-potential-difference-measurement of luminance is performed, as it is shown in drawing 13 , they are 800 cd/m<sup>2</sup> at 8V. Brightness was obtained.

[0085] After producing these organic electroluminescence devices, although it was left for one month under nitrogen-gas-atmosphere mind, component degradation was not observed. Moreover, initial brightness 300 cd/m<sup>2</sup> The current value was energized uniformly and continuation luminescence was carried out, and when carrying out forcible degradation, it was 700 hours until brightness was halved.

[0086] Example 3 this example is R1 among the above-mentioned styryl compounds of a general formula (1). A non-permuted phenyl group and R2 It is the example which produced the organic electroluminescence devices of double hetero structure, using the compound of above-mentioned structure-expression (20)-2 which had 9 and 10-dicyano anthracene radical in a non-permuted naphthyl group and X as a luminescent material.

[0087] First, the 30mmx30mm glass substrate with which the anode plate which consists of ITO with a thickness of 100nm was formed on one front face into the vacuum evaporation system was set. The substrate was approached, the metal mask which has two or more 2.0mmx2.0mm unit openings as a vacuum evaporation mask has been arranged, and alpha-NPD of the above-mentioned structure expression was formed as an electron hole transportation layer in

thickness of 30nm under the vacuum of  $10^{-4}$  or less Pa with the vacuum deposition method. The vacuum evaporation rate was carried out in 0.2nm/second.

[0088] Furthermore, the compound of above-mentioned structure-expression (20)-2 was vapor-deposited in contact with the electron hole transportation layer as a luminescent material. The above-mentioned structure expression (20) Thickness of the luminous layer which consists of a compound of -2 was also set to 30nm, and the vacuum evaporation rate was carried out in 0.2nm/second.

[0089] Furthermore, it is Alq3 of the above-mentioned structure expression as an electronic transportation ingredient. It vapor-deposited in contact with the luminous layer. Alq3 Thickness was set to 30nm and the vacuum evaporation rate was carried out in 0.2nm/second.

[0090] The cascade screen of Mg and Ag was adopted as a cathode material, and by vacuum evaporation, this was also formed in the thickness of 50nm (Mg film) and 150nm (Ag film) as vacuum evaporation rate 1nm/a second, and produced the \*\*\*\* organic electroluminescence devices shown in drawing 4 by the example 3.

[0091] Thus, forward bias direct current voltage was applied to the organic electroluminescence devices of the produced example 3 under nitrogen-gas-atmosphere mind, and the luminescence property was evaluated.

The luminescent color was red, and as a result of performing spectrometry, as shown in drawing 14 , it obtained the spectrum which has a luminescence peak in 710nm. Moreover, when the electrical-potential-difference-measurement of luminance is performed, as it is shown in drawing 15 , they are 3000 cd/m<sup>2</sup> at 8V. Brightness was obtained.

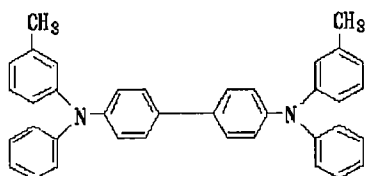
[0092] After producing these organic electroluminescence devices, although it was left for one month under nitrogen-gas-atmosphere mind, component degradation was not observed. Moreover, initial brightness 300 cd/m<sup>2</sup> The current value was energized uniformly and continuation luminescence was carried out, and when carrying out forcible degradation, it was 1500 hours until brightness was halved.

[0093] Changed to alpha-NPD as an example 4 electron-hole transportability ingredient, and TPD (triphenyl diamine derivative) of the following structure expression was used, and also lamination and the forming-membranes method produced organic electroluminescence devices based on the example 2.

[0094]

[Formula 48]

TPD :



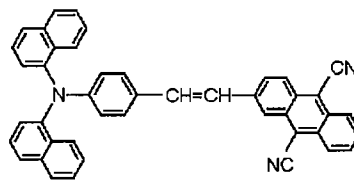


[0095] The organic electroluminescence devices of this example also presented luminescence of the same red as an example 2. The spectrum was in agreement with the spectrum of the organic electroluminescence devices of an example 2 as a result of spectrometry.

[0096] Example 5 this example is R1 among the styryl compounds of a general formula (1), and R2. The organic electroluminescence devices of single hetero structure were produced like the example 2 except this, using the compound of following structure-expression (20)-4 which had 9 and 10-dicyano anthracene radical in a non-permuted naphthyl group and X as an electronic transportability luminescent material.

[0097]

[Formula 49] Structure expression (20) -4 :



[0098] Thus, forward bias direct current voltage was applied to the organic electroluminescence devices of the produced example 5 under nitrogen-gas-atmosphere mind, and the luminescence property was evaluated. The luminescent color was red, and as a result of performing spectrometry, as

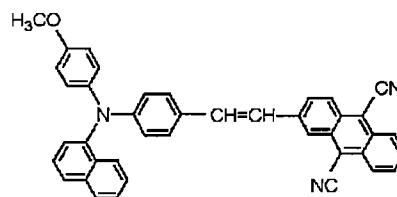
shown in drawing 16 , it obtained the spectrum which has a luminescence peak in 700nm. Moreover, when the electrical-potential-difference-measurement of luminance is performed, as it is shown in drawing 17 , they are 700 cd/m<sup>2</sup> at 7V. Brightness was obtained.

[0099] After producing these organic electroluminescence devices, although it was left for one month under nitrogen-gas-atmosphere mind, component degradation was not observed. Moreover, initial brightness 300 cd/m<sup>2</sup> The current value was energized uniformly and continuation luminescence was carried out, and when carrying out forcible degradation, it was 500 hours until brightness was halved.

[0100] Example 6 this example is R1 among the above-mentioned styryl compounds of a general formula (1). 4-methoxyphenyl radical and R2 It is the example which produced the organic electroluminescence devices of single hetero layer structure, using the compound of following structure-expression (20)-3 which had 9 and 10-dicyano anthracene radical in a non-permuted naphthyl group and X as an electronic transportability ingredient. Layer structure and the forming-membranes method produced organic electroluminescence devices based on the example 2.

[0101]

[Formula 50] Structure expression (20) -3 :



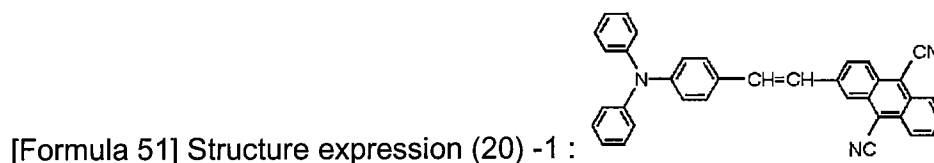
[0102] Thus, forward bias direct current voltage was applied to the organic electroluminescence devices of the produced example 6 under nitrogen-gas-atmosphere mind, and the luminescence property was evaluated. The luminescent color was red, and as a result of performing spectrometry, as shown in drawing 18 , it obtained the spectrum which has a luminescence peak in 750nm. When the electrical-potential-difference-measurement of luminance is performed, as it is shown in drawing 19 , they are 130 cd/m<sup>2</sup> at 7V. Brightness was obtained.

[0103] After producing these organic electroluminescence devices, although it was left for one month under nitrogen-gas-atmosphere mind, component degradation was not observed.

[0104] Example 7 this example is R1 among the styryl compounds of a general formula (1), and R2. It is the example which produced the organic electroluminescence devices of single hetero structure, using the compound of following structure-expression (20)-1 which had 9 and 10-dicyano anthracene radical in a non-permuted phenyl group and X as an electronic transportability

luminescent material. Layer structure and the forming-membranes method produced organic electroluminescence devices based on the example 2.

[0105]



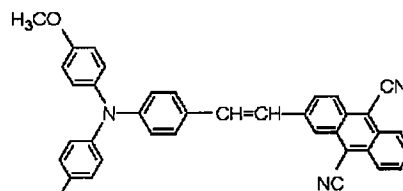
[0106] Thus, forward bias direct current voltage was applied to the organic electroluminescence devices of the produced example 7 under nitrogen-gas-atmosphere mind, and the luminescence property was evaluated.

The luminescent color is red and is 100 cd/m<sup>2</sup> at 7V. Brightness was obtained.

[0107] After producing these organic electroluminescence devices, although it was left for one month under nitrogen-gas-atmosphere mind, component degradation was not observed.

[0108] Example 8 this example is R1 among the styryl compounds of a general formula (1), and R2. It is the example which produced the organic electroluminescence devices of single hetero structure, using the compound of following structure-expression (20)-5 which had 9 and 10-dicyano anthracene radical in 4-methoxypheny radical and X as an electronic transportability luminescent material. Layer structure and the forming-membranes method produced organic electroluminescence devices based on the example 2.

[0109]



[Formula 52] Structure expression (20) -5 :

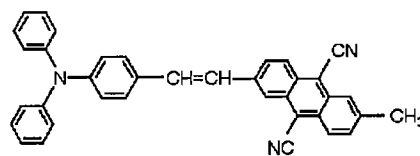
[0110] Thus, forward bias direct current voltage was applied to the organic electroluminescence devices of the produced example 8 under nitrogen-gas-atmosphere mind, and the luminescence property was evaluated.

The luminescent color is red and is 80 cd/m<sup>2</sup> at 7V. Brightness was obtained.

[0111] After producing these organic electroluminescence devices, although it was left for one month under nitrogen-gas-atmosphere mind, component degradation was not observed.

[0112] Example 9 this example is R1 among the styryl compounds of a general formula (1), and R2. It is the example which produced the organic electroluminescence devices of single hetero structure, using the compound of following structure-expression (20)-6 which had the 2-methyl -9 and 10-dicyano anthracene radical in a non-permuted phenyl group and X as an electronic transportability luminescent material. Layer structure and the forming-membranes method produced organic electroluminescence devices based on the example 2.

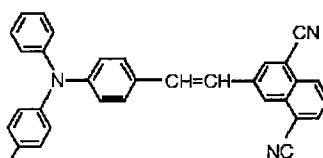
[Formula 53] Structure expression (20) -6 :

Cc1ccc2c(c1)c(c3ccccc3n(c2)c4ccccc4)C#N

[0114] Thus, forward bias direct current voltage was applied to the organic electroluminescence devices of the produced example 9 under nitrogen-gas-atmosphere condition, and the luminescence property was evaluated. The luminescent color is red and is 120 cd/m<sup>2</sup> at 7V. Brightness was obtained.

[0116] Example 10 this example is R1 among the styryl compounds of a general formula (1). A non-permuted phenyl group and R2 It is the example which produced the organic electroluminescence devices of single hetero structure, using the compound of following structure-expression (20)-8 which had 1 and 5-dicyano naphthyl group in 4-methoxyphenyl radical and X as an electronic transportability luminescent material. Layer structure and the forming-membranes method produced organic electroluminescence devices based on the example 2.

[0117]



[Formula 54] Structure expression (20) -8 :  $\text{H}_3\text{CO}$

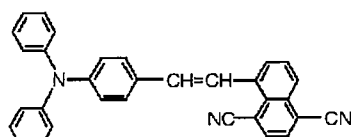
[0118] Thus, forward bias direct current voltage was applied to the organic electroluminescence devices of the produced example 10 under nitrogen-gas-atmosphere condition, and the luminescence property was evaluated.

The luminescent color is red and is 800 cd/m<sup>2</sup> at 7V. Brightness was obtained.

[0119] After producing these organic electroluminescence devices, although it was left for one month under nitrogen-gas-atmosphere condition, component degradation was not observed.

[0120] Example 11 this example is R1 among the styryl compounds of a general formula (1). A non-permuted phenyl group and R2 It is the example which produced the organic electroluminescence devices of single hetero structure, using the compound of following structure-expression (20)-9 which had 1 and 4-dicyano naphthyl group in 4-methoxyphenyl radical and X as an electronic transportability luminescent material. Layer structure and the forming-membranes method produced organic electroluminescence devices based on the example 2.

[0121]



[Formula 55] Structure expression (20) -9 :  $\text{H}_3\text{CO}$

[0122] Thus, forward bias direct current voltage was applied to the organic electroluminescence devices of the produced example 11 under nitrogen-gas-atmosphere condition, and the luminescence property was evaluated.

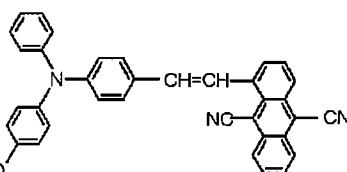
The luminescent color is red and is 1200 cd/m<sup>2</sup> at 7V. Brightness was obtained.

[0123] After producing these organic electroluminescence devices, although it was left for one month under nitrogen-gas-atmosphere condition, component degradation was not observed.

[0124] Example 12 this example is R1 among the styryl compounds of a general formula (1). A non-permuted phenyl group and R2 It is the example which produced the organic electroluminescence devices of single hetero structure, using the compound of following structure-expression (20)-10 which had 9 and 10-dicyano anthracene radical in 4-methoxyphenyl radical and X as an electronic transportability luminescent material. Layer structure and the forming-membranes method produced organic electroluminescence devices based on the example 2.

[0125]





[Formula 56] Structure expression (20) -10 :  $\text{H}_3\text{CO}$

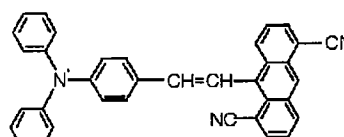
[0126] Thus, forward bias direct current voltage was applied to the organic electroluminescence devices of the produced example 12 under nitrogen-gas-atmosphere condition, and the luminescence property was evaluated.

The luminescent color is red and is 1500 cd/m<sup>2</sup> at 7V. Brightness was obtained.

[0127] After producing these organic electroluminescence devices, although it was left for one month under nitrogen-gas-atmosphere condition, component degradation was not observed.

[0128] Example 13 this example is R1 among the styryl compounds of a general formula (1). A non-permuted phenyl group and R2 It is the example which produced the organic electroluminescence devices of single hetero structure, using the compound of following structure-expression (20)-11 which had 2 and 6-dicyano naphthyl group in 4-methoxyphenyl radical and X as an electronic transportability luminescent material. Layer structure and the forming-membranes method produced organic electroluminescence devices based on the example 2.

[0129]



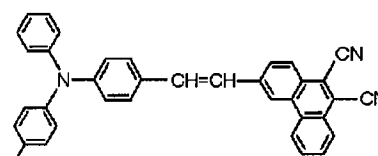
[Formula 57] Structure expression (20) -11 :  $\text{H}_3\text{CO}$

[0130] Thus, forward bias direct current voltage was applied to the organic electroluminescence devices of the produced example 13 under nitrogen-gas-atmosphere mind, and the luminescence property was evaluated. The luminescent color is red and is 1700 cd/m<sup>2</sup> at 7V. Brightness was obtained.

[0131] After producing these organic electroluminescence devices, although it was left for one month under nitrogen-gas-atmosphere mind, component degradation was not observed.

[0132] Example 14 this example is R1 among the styryl compounds of a general formula (1). A non-permuted phenyl group and R2 It is the example which produced the organic electroluminescence devices of single hetero structure, using the compound of following structure-expression (20)-12 which had a phenanthrene radical in 4-methoxypheny radical and X as an electronic transportability luminescent material. Layer structure and the forming-membranes method produced organic electroluminescence devices based on the example 2.

[0133]



[Formula 58] Structure expression (20) -12 :  $\text{H}_3\text{CO}$

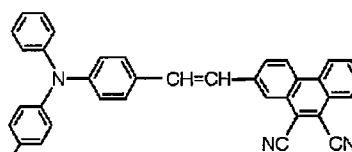
[0134] Thus, forward bias direct current voltage was applied to the organic electroluminescence devices of the produced example 14 under nitrogen-gas-atmosphere condition, and the luminescence property was evaluated.

The luminescent color is red and is 2200 cd/m<sup>2</sup> at 7V. Brightness was obtained.

[0135] After producing these organic electroluminescence devices, although it was left for one month under nitrogen-gas-atmosphere condition, component degradation was not observed.

[0136] Example 15 this example is R1 among the styryl compounds of a general formula (1). A non-permuted phenyl group and R2 It is the example which produced the organic electroluminescence devices of single hetero structure, using the compound of following structure-expression (20)-13 which had a phenanthrene radical in 4-methoxyphenyl radical and X as an electronic transportability luminescent material. Layer structure and the forming-membranes method produced organic electroluminescence devices based on the example 2.

[0137]



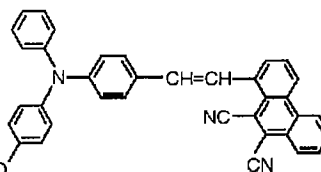
[Formula 59] Structure expression (20) -13 : H<sub>3</sub>CO

[0138] Thus, forward bias direct current voltage was applied to the organic electroluminescence devices of the produced example 15 under nitrogen-gas-atmosphere condition, and the luminescence property was evaluated. The luminescent color is red and is 2100 cd/m<sup>2</sup> at 7V. Brightness was obtained.

[0139] After producing these organic electroluminescence devices, although it was left for one month under nitrogen-gas-atmosphere condition, component degradation was not observed.

[0140] Example 16 this example is R1 among the styryl compounds of a general formula (1). A non-permuted phenyl group and R2 It is the example which produced the organic electroluminescence devices of single hetero structure, using the compound of following structure-expression (20)-14 which had a phenanthrene radical in 4-methoxyphenyl radical and X as an electronic transportability luminescent material. Layer structure and the forming-membranes method produced organic electroluminescence devices based on the example 2.

[0141]



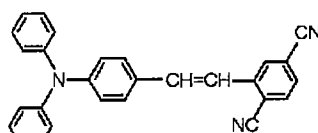
[Formula 60] Structure expression (20) -14 :  $\text{H}_3\text{CO}$

[0142] Thus, forward bias direct current voltage was applied to the organic electroluminescence devices of the produced example 16 under nitrogen-gas-atmosphere condition, and the luminescence property was evaluated. The luminescent color is red and is 1800 cd/m<sup>2</sup> at 7V. Brightness was obtained.

[0143] After producing these organic electroluminescence devices, although it was left for one month under nitrogen-gas-atmosphere condition, component degradation was not observed.

[0144] Example 17 this example is R1 among the styryl compounds of a general formula (1). A non-permuted phenyl group and R2 It is the example which produced the organic electroluminescence devices of single hetero structure, using the compound of following structure-expression (20)-15 which had a dicyano phenyl group in 4-methoxyphenyl radical and X as an electronic transportability luminescent material. Layer structure and the forming-membranes method produced organic electroluminescence devices based on the example 2.

[0145]



[Formula 61] Structure expression (20) -15 :  $\text{H}_3\text{CO}$

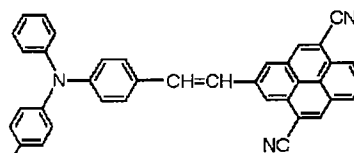
[0146] Thus, forward bias direct current voltage was applied to the organic electroluminescence devices of the produced example 17 under nitrogen-gas-atmosphere mind, and the luminescence property was evaluated.

The luminescent color is red and is 4800 cd/m<sup>2</sup> at 8V. Brightness was obtained.

[0147] After producing these organic electroluminescence devices, although it was left for one month under nitrogen-gas-atmosphere mind, component degradation was not observed.

[0148] Example 18 this example is R1 among the styryl compounds of a general formula (1). A non-permuted phenyl group and R2 It is the example which produced the organic electroluminescence devices of single hetero structure, using the compound of following structure-expression (20)-16 which had a dicyano permutation pyrenyl radical in 4-methoxypheny radical and X as an electronic transportability luminescent material. Layer structure and the forming-membranes method produced organic electroluminescence devices based on the example 2.

[0149]



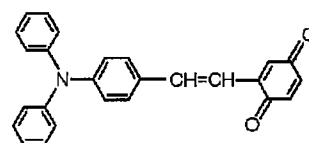
[Formula 62] Structure expression (20) -16 :  $\text{H}_3\text{CO}$

[0150] Thus, forward bias direct current voltage was applied to the organic electroluminescence devices of the produced example 18 under nitrogen-gas-atmosphere mind, and the luminescence property was evaluated. The luminescent color is red and is 800 cd/m<sup>2</sup> at 8V. Brightness was obtained.

[0151] After producing these organic electroluminescence devices, although it was left for one month under nitrogen-gas-atmosphere mind, component degradation was not observed.

[0152] Example 19 this example is R1 among the styryl compounds of a general formula (1). A non-permuted phenyl group and R2 It is the example which produced the organic electroluminescence devices of single hetero structure, using the compound of following structure-expression (20)-17 which had a quinone in 4-methoxypheny radical and X as an electronic transportability luminescent material. Layer structure and the forming-membranes method produced organic electroluminescence devices based on the example 2.

[0153]



[Formula 63] Structure expression (20) -17 :  $\text{H}_3\text{CO}$

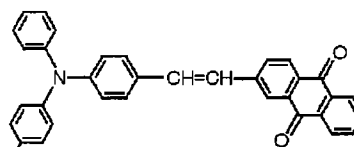
[0154] Thus, forward bias direct current voltage was applied to the organic electroluminescence devices of the produced example 19 under nitrogen-gas-atmosphere condition, and the luminescence property was evaluated. The luminescent color is red and is 1500 cd/m<sup>2</sup> at 8V. Brightness was obtained.

[0155] After producing these organic electroluminescence devices, although it was left for one month under nitrogen-gas-atmosphere condition, component degradation was not observed.

[0156] Example 20 this example is R1 among the styryl compounds of a general formula (1). A non-permuted phenyl group and R2 It is the example which produced the organic electroluminescence devices of single hetero structure, using the compound of following structure-expression (20)-18 which had anthraquinone in 4-methoxyphenyl radical and X as an electronic transportability luminescent material. Layer structure and the forming-membranes method produced organic electroluminescence devices based on the example 2.

[0157]





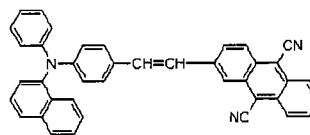
[Formula 64] Structure expression (20) -18 :  $\text{H}_3\text{CO}$

[0158] Thus, forward bias direct current voltage was applied to the organic electroluminescence devices of the produced example 20 under nitrogen-gas-atmosphere mind, and the luminescence property was evaluated.

The luminescent color is red and is 1800 cd/m<sup>2</sup> at 8V. Brightness was obtained.

[0159] After producing these organic electroluminescence devices, although it was left for one month under nitrogen-gas-atmosphere mind, component degradation was not observed.

[0160] Example 21 this example is an example which produced the organic electroluminescence devices which used the compound of following structure-expression (37)-1 as an electron hole transportability luminous layer among the above-mentioned amino styryl compounds of a general formula [I].



[Formula 65] Structure expression (37) -1 :

[0161] First, the 30mmx30mm glass substrate with which the anode plate which consists of ITO with a thickness of 100nm was formed on one front face into the

[0162] Furthermore, the bathocuproine of the following structure expression was vapor-deposited in contact with the electron hole transportation layer as a hole blocking layer ingredient. The thickness of this hole blocking layer that consists of bathocuproine set to 15nm, and the vacuum evaporation rate was carried out in 0.1nm/second.

Cc1nc2c3ccccc3c2n(c1)c1ccccc1

[Formula 66] Bathocuproine :

[0164] The cascade screen of Mg and Ag was adopted as a cathode material, and by vacuum evaporation, this was also formed in the thickness of 50nm (Mg film) and 150nm (Ag film) as vacuum evaporation rate 1nm/a second, and produced the \*\*\*\* organic electroluminescence devices shown in drawing 7 by the example 21.

[0165] Thus, forward bias direct current voltage was applied to the organic electroluminescence devices of the produced example 21 under nitrogen-gas-atmosphere mind, and the luminescence property was evaluated. The luminescent color was red, and as a result of performing spectrometry, it obtained the spectrum which has a luminescence peak near 710nm. The spectroscope which used the photodiode array by the Otsuka electronic company as the detector was used for spectrometry. Moreover, when the electrical-potential-difference-measurement of luminance was performed, the brightness of 800 cd/m<sup>2</sup> was obtained by 8V.

[0166] After producing these organic electroluminescence devices, although it was left for one month under nitrogen-gas-atmosphere mind, component degradation was not observed. Moreover, when energizing a current value uniformly, carrying out continuation luminescence and carrying out forcible degradation by initial brightness 100 cd/m<sup>2</sup>, it was 800 hours until brightness was halved.

[0167] Example 22 this example is an example which produced the organic electroluminescence devices which used the compound of following structure-expression (37)-1 as an electronic transportability luminous layer among the compounds of a general formula [I].

[0168] First, the 30mmx30mm glass substrate with which the anode plate which consists of ITO with a thickness of 100nm was formed on one front face into the vacuum evaporation system was set. The substrate was approached, the metal mask which has two or more 2.0mmx2.0mm unit openings as a vacuum evaporation mask has been arranged, and alpha-NPD of the above-mentioned structure expression was formed in thickness of 30nm under the vacuum of  $10^{-4}$  or less Pa with the vacuum deposition method. The vacuum evaporation rate was carried out in 0.1nm/second.

[0169] Furthermore, the compound of above-mentioned structure-expression (37)-1 was vapor-deposited in contact with the electron hole transportation layer. This structure expression (37) Thickness of the electron transport layer (\*\*\*\*\*) which consists of a compound of -1 was also set to 30nm, and the vacuum evaporation rate was made respectively in 0.2nm/second.

[0170] Furthermore, the bathocuproine of the above-mentioned structure expression was vapor-deposited in contact with the luminous layer as a hole blocking layer ingredient. The thickness of this hole blocking layer that consists

of bathocuproine set to 15nm, and the vacuum evaporation rate was carried out in 0.1nm/second. Furthermore, Alq3 of the above-mentioned structure expression was vapor-deposited in contact with the hole blocking layer as an electron transport layer ingredient. Thickness of this electron transport layer that consists of Alq3 was also set to 30nm, and the vacuum evaporation rate was carried out in 0.2nm/second.

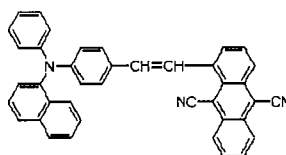
[0171] The cascade screen of Mg and Ag was adopted as a cathode material, and by vacuum evaporation, this was also formed in the thickness of 50nm (Mg) and 150nm (Ag film) as vacuum evaporation rate 1nm/a second, and produced the \*\*\*\* organic electroluminescence devices shown in drawing 8 .

[0172] Thus, forward bias direct current voltage was applied to the organic electroluminescence devices of the produced example 22 under nitrogen-gas-atmosphere mind, and the luminescence property was evaluated. The luminescent color was red, and as a result of performing spectrometry like an example 21, it obtained the spectrum which has a luminescence peak near 710nm. Moreover, when the electrical-potential-difference-measurement of luminance was performed, the brightness of 600 cd/m<sup>2</sup> was obtained by 8V.

[0173] After producing these organic electroluminescence devices, although it was left for one month under nitrogen-gas-atmosphere mind, component degradation was not observed. Moreover, when energizing a current value

uniformly, carrying out continuation luminescence and carrying out forcible degradation by initial brightness 100 cd/m<sup>2</sup>, it was 700 hours until brightness was halved.

[0174] Example 23 this example is an example which produced the organic electroluminescence devices which used the compound of following structure-expression (37)-2 as an electronic transportability luminous layer among the above-mentioned amino styryl compounds of a general formula [I].



[Formula 67] Structure expression (37) -2 :

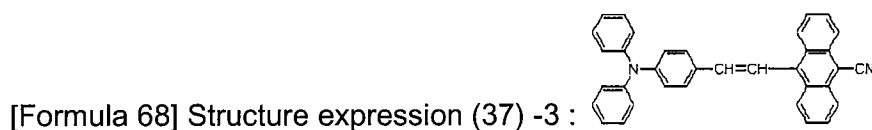
[0175] Layer structure and the forming-membranes method produced organic electroluminescence devices based on the example 22.

[0176] Thus, forward bias direct current voltage was applied to the organic electroluminescence devices of the produced example 23 under nitrogen-gas-atmosphere mind, and the luminescence property was evaluated. The luminescent color was red, and as a result of performing spectrometry like an example 21, it obtained the spectrum which has a luminescence peak near 680nm. Moreover, when the electrical-potential-difference-measurement of luminance was performed, the brightness of 500 cd/m<sup>2</sup> was obtained by 8V.

[0177] After producing these organic electroluminescence devices, although it

was left for one month under nitrogen-gas-atmosphere mind, component degradation was not observed. Moreover, when energizing a current value uniformly, carrying out continuation luminescence and carrying out forcible degradation by initial brightness 100 cd/m<sup>2</sup>, it was 400 hours until brightness was halved.

[0178] Example 24 this example is an example which produced the organic electroluminescence devices which used the compound of following structure-expression (37)-3 as an electronic transportability luminous layer among the above-mentioned amino styryl compounds of a general formula [I].



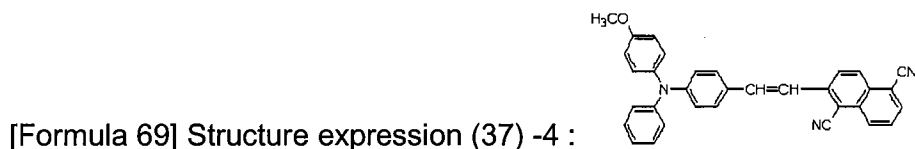
[0179] Layer structure and the forming-membranes method produced organic electroluminescence devices based on the example 22.

[0180] Thus, forward bias direct current voltage was applied to the organic electroluminescence devices of the produced example 24 under nitrogen-gas-atmosphere mind, and the luminescence property was evaluated. The luminescent color was orange, and as a result of performing spectrometry like an example 21, it obtained the spectrum which has a luminescence peak near 620nm. Moreover, when the electrical-potential-difference-measurement of

luminance was performed, the brightness of 700 cd/m<sup>2</sup> was obtained by 8V.

[0181] After producing these organic electroluminescence devices, although it was left for one month under nitrogen-gas-atmosphere mind, component degradation was not observed. Moreover, when energizing a current value uniformly, carrying out continuation luminescence and carrying out forcible degradation by initial brightness 100 cd/m<sup>2</sup>, it was 400 hours until brightness was halved.

[0182] Example 25 this example is an example which produced the organic electroluminescence devices which used the compound of following structure-expression (37)-4 as an electronic transportability luminous layer among the above-mentioned amino styryl compounds of a general formula [I].



[0183] Layer structure and the forming-membranes method produced organic electroluminescence devices based on the example 22.

[0184] Thus, forward bias direct current voltage was applied to the organic electroluminescence devices of the produced example 25 under nitrogen-gas-atmosphere mind, and the luminescence property was evaluated.

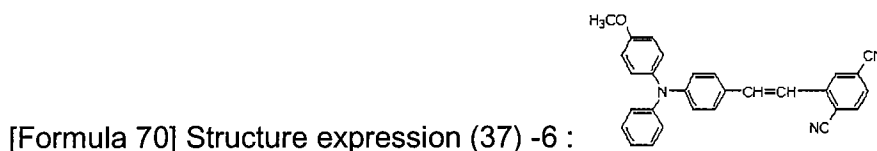
The luminescent color was red, and as a result of performing spectrometry like



an example 21, it obtained the spectrum which has a luminescence peak near 630nm. Moreover, when the electrical-potential-difference-measurement of luminance was performed, the brightness of 2000 cd/m<sup>2</sup> was obtained by 8V.

[0185] After producing these organic electroluminescence devices, although it was left for one month under nitrogen-gas-atmosphere mind, component degradation was not observed. Moreover, when energizing a current value uniformly, carrying out continuation luminescence and carrying out forcible degradation by initial brightness 100 cd/m<sup>2</sup>, it was 800 hours until brightness was halved.

[0186] Example 26 this example is an example which produced the organic electroluminescence devices which used the compound of following structure-expression (37)-6 as an electronic transportability luminous layer among the above-mentioned amino styryl compounds of a general formula [I].



[0187] Layer structure and the forming-membranes method produced organic electroluminescence devices based on the example 22.

[0188] Thus, forward bias direct current voltage was applied to the organic electroluminescence devices of the produced example 26 under

nitrogen-gas-atmosphere mind, and the luminescence property was evaluated.

The luminescent color was orange, and as a result of performing spectrometry like an example 21, it obtained the spectrum which has a luminescence peak near 610nm. Moreover, when the electrical-potential-difference-measurement of luminance was performed, the brightness of 2000 cd/m<sup>2</sup> was obtained by 8V.

[0189] After producing these organic electroluminescence devices, although it was left for one month under nitrogen-gas-atmosphere mind, component degradation was not observed. Moreover, when energizing a current value uniformly, carrying out continuation luminescence and carrying out forcible degradation by initial brightness 100 cd/m<sup>2</sup>, it was 550 hours until brightness was halved.

[0190] Example 27 this example is an example which produced the organic electroluminescence devices which used the compound of following structure-expression (37)-7 as an electronic transportability luminous layer among the above-mentioned amino styryl compounds of a general formula [I].

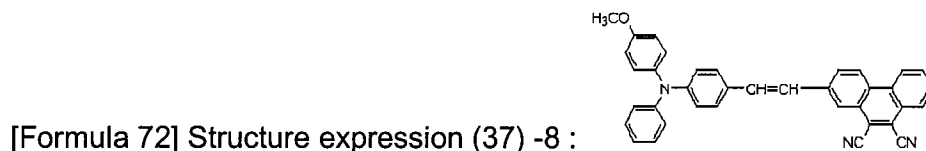


[0191] Layer structure and the forming-membranes method produced organic electroluminescence devices based on the example 22.

[0192] Thus, forward bias direct current voltage was applied to the organic electroluminescence devices of the produced example 27 under nitrogen-gas-atmosphere mind, and the luminescence property was evaluated. The luminescent color was red, and as a result of performing spectrometry like an example 21, it obtained the spectrum which has a luminescence peak near 650nm. Moreover, when the electrical-potential-difference-measurement of luminance was performed, the brightness of 700 cd/m<sup>2</sup> was obtained by 8V.

[0193] After producing these organic electroluminescence devices, although it was left for one month under nitrogen-gas-atmosphere mind, component degradation was not observed. Moreover, when energizing a current value uniformly, carrying out continuation luminescence and carrying out forcible degradation by initial brightness 100 cd/m<sup>2</sup>, it was 400 hours until brightness was halved.

[0194] Example 28 this example is an example which produced the organic electroluminescence devices which used the compound of following structure-expression (37)-8 as an electronic transportability luminous layer among the above-mentioned amino styryl compounds of a general formula [I].



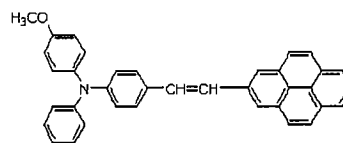
[0195] Layer structure and the forming-membranes method produced organic electroluminescence devices based on the example 22.

[0196] Thus, forward bias direct current voltage was applied to the organic electroluminescence devices of the produced example 28 under nitrogen-gas-atmosphere mind, and the luminescence property was evaluated. The luminescent color was red, and as a result of performing spectrometry like an example 21, it obtained the spectrum which has a luminescence peak near 650nm. Moreover, when the electrical-potential-difference-measurement of luminance was performed, the brightness of 650 cd/m<sup>2</sup> was obtained by 8V.

[0197] After producing these organic electroluminescence devices, although it was left for one month under nitrogen-gas-atmosphere mind, component degradation was not observed. Moreover, when energizing a current value uniformly, carrying out continuation luminescence and carrying out forcible degradation by initial brightness 100 cd/m<sup>2</sup>, it was 800 hours until brightness was halved.

[0198] Example 29 this example is an example which produced the organic electroluminescence devices which used the compound of following structure-expression (37)-11 as an electronic transportability luminous layer among the above-mentioned amino styryl compounds of a general formula [I].

[Formula 73] Structure expression (37) -11 :



[0199] Layer structure and the forming-membranes method produced organic electroluminescence devices based on the example 22.

[0200] Thus, forward bias direct current voltage was applied to the organic electroluminescence devices of the produced example 29 under nitrogen-gas-atmosphere mind, and the luminescence property was evaluated.

The luminescent color was orange, and as a result of performing spectrometry like an example 21, it obtained the spectrum which has a luminescence peak near 590nm. Moreover, when the electrical-potential-difference-measurement of luminance was performed, the brightness of 730 cd/m<sup>2</sup> was obtained by 8V.

[0201] After producing these organic electroluminescence devices, although it was left for one month under nitrogen-gas-atmosphere mind, component degradation was not observed. Moreover, when energizing a current value uniformly, carrying out continuation luminescence and carrying out forcible degradation by initial brightness 100 cd/m<sup>2</sup>, it was 850 hours until brightness was halved.

[0202]

[Function and Effect of the Invention] Since at least one sort of a styryl

compound expressed with said organic layer by said general formula (1) or [I] is contained in the organic electroluminescence devices by which the organic layer which has a luminescence field is prepared between an anode plate and cathode according to the organic electroluminescence devices of this invention, the organic electroluminescence devices which have stable red luminescence by high brightness can be offered.

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## DESCRIPTION OF DRAWINGS

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[Brief Description of the Drawings]

[Drawing 1] It is the important section outline sectional view of an example of the organic electroluminescence devices based on this invention.

[Drawing 2] It is the important section outline sectional view of other examples of \*\*\*\* organic electroluminescence devices.

[Drawing 3] It is the important section outline sectional view of other examples of \*\*\*\* organic electroluminescence devices.

[Drawing 4] It is the important section outline sectional view of other examples of \*\*\*\* organic electroluminescence devices.

[Drawing 5] It is the important section outline sectional view of other examples of

\*\*\*\* organic electroluminescence devices.

[Drawing 6] It is the important section outline sectional view of other examples of

\*\*\*\* organic electroluminescence devices.

[Drawing 7] It is the important section outline sectional view of other examples of

\*\*\*\* organic electroluminescence devices.

[Drawing 8] It is the important section outline sectional view of the example of

further others of \*\*\*\* organic electroluminescence devices.

[Drawing 9] It is the block diagram of the full color flat-surface display using \*\*\*\*

organic electroluminescence devices.

[Drawing 10] It is the emission spectrum Fig. of the organic electroluminescence

devices by the example 1 of this invention.

[Drawing 11] It is the electrical-potential-difference-brightness property Fig. of

the organic electroluminescence devices by the \*\*\*\* example 1.

[Drawing 12] It is the emission spectrum Fig. of the organic electroluminescence

devices by the \*\*\*\* example 2.

[Drawing 13] It is the electrical-potential-difference-brightness property Fig. of

the organic electroluminescence devices by the \*\*\*\* example 2.

[Drawing 14] It is the emission spectrum Fig. of the organic electroluminescence

devices by the \*\*\*\* example 3.

[Drawing 15] It is the electrical-potential-difference-brightness property Fig. of

the organic electroluminescence devices by the \*\*\*\* example 3.

[Drawing 16] It is the emission spectrum Fig. of the organic electroluminescence devices by the \*\*\*\* example 5.

[Drawing 17] It is the electrical-potential-difference-brightness property Fig. of the organic electroluminescence devices by the \*\*\*\* example 5.

[Drawing 18] It is the emission spectrum Fig. of the organic electroluminescence devices by the \*\*\*\* example 6.

[Drawing 19] It is the electrical-potential-difference-brightness property Fig. of the organic electroluminescence devices by the \*\*\*\* example 6.

[Description of Notations]

1 [ -- An organic layer, 6 / -- An electron hole transportation layer, 7 / -- An electron transport layer, 8 / -- A power source, 10 / -- An electron hole transportation layer, 11 / -- A luminous layer, 12 / -- An electron transport layer, 14 / -- A luminance-signal circuit, 15 / -- A control circuit, 20 / -- Luminescence light, 21 / -- A hole (electron hole) blocking layer, A, B, C, D / -- Organic electroluminescence devices ] -- A substrate, 2 -- transparent electrode (anode plate), 3 -- Cathode, 4 -- A protective coat, 5, 5a, 5b

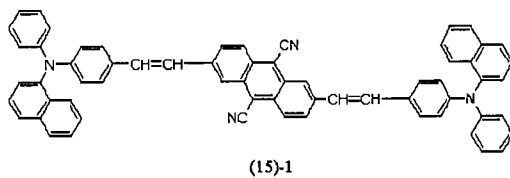


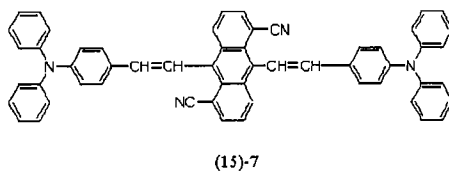
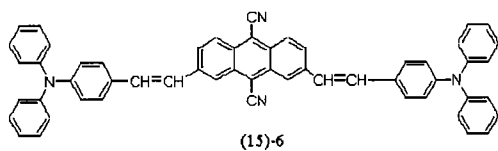
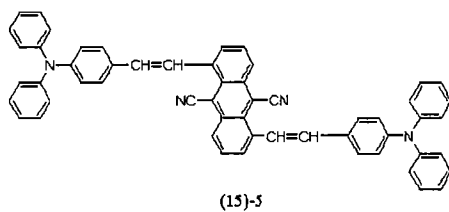
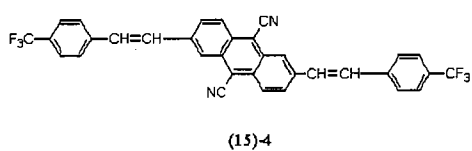
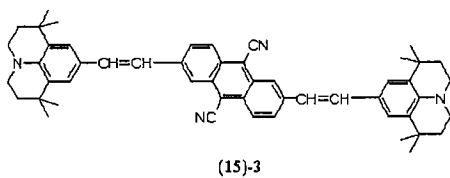
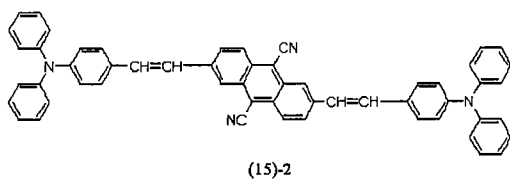
exists in contact with the cathode side of the electronic transportability luminescence layer of a parenthesis and which were indicated to claim 17.

[Claim 21] Organic electroluminescence devices in which said hole blocking layer exists in contact with the cathode side of the layer which said organic layer is having the organic laminated structure to which the laminating of a hole transportation layer, a luminous layer, and the electron transport layer was carried out, and consisted of styryl compounds of said organic layers in which said luminous layer is shown by said general formula [I] at least, and consisted of said styryl compounds and which were indicated to claim 17.

[Claim 22] Organic electroluminescence devices characterized by a hole blocking layer existing in contact with the cathode side of the layer which consisted of styryl compounds in which at least one layer in said organic layer is shown by following structure-expression (15)-1-(15)-7 in the organic electroluminescence devices by which the organic layer which has a luminescence field is prepared between an anode plate and cathode, and consisted of said styryl compounds.

[Formula 13]





[Claim 23] Organic electroluminescence devices to which said hole blocking layer exists in a cathode side in contact with the layer which said organic layer is

having the organic laminated structure to which the laminating of a hole transportation layer and the electron transport layer was carried out, and consisted of styryl compounds of said organic layers in which an electron transport layer is shown by said structure-expression (15)-1-(15)-7 at least, and consisted of said styryl compounds and which were indicated to claim 22.

[Claim 24] Organic electroluminescence devices to which said hole blocking layer exists in a cathode side in contact with the layer which said organic layer is having the organic laminated structure to which the laminating of a hole transportation layer and the electron transport layer was carried out, and consisted of styryl compounds of said organic layers in which a hole transportation layer is shown by said structure-expression (15)-1-(15)-7 at least, and consisted of said styryl compounds and which were indicated to claim 22.

[Claim 25] Said organic layer is having the organic laminated structure to which the laminating of a hole transportation layer and the electron transport layer was carried out. It consists of styryl compounds in which said hole transportation layer is shown by said structure-expression (15)-1-(15)-7. And organic electroluminescence devices in which it consists of styryl compounds in which said electron transport layer is shown by said structure-expression (15)-1-(15)-7, and said hole blocking layer exists in contact with the cathode side of said electronic transportability luminous layer and which were indicated to claim 22.

[Claim 26] Organic electroluminescence devices in which said hole blocking layer exists in contact with the cathode side of the layer which said organic layer is having the organic laminated structure to which the laminating of a hole transportation layer, a luminous layer, and the electron transport layer was carried out, and consisted of styryl compounds of said organic layers in which said luminous layer is shown by said structure-expression (15)-1-(15)-7 at least, and consisted of said styryl compounds and which were indicated to claim 22.

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## DETAILED DESCRIPTION

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[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to the organic electroluminescence devices (organic EL device) by which the organic layer which has a luminescence field is prepared between an anode plate and cathode.

[0002]

[Description of the Prior Art] The lightweight and efficient flat-panel display is briskly studied and developed as an object for the screen display of a computer or television.

[0003] first -- although brightness of the Braun tube (CRT) is high, and it is used most mostly as a current display since color reproduction nature is good -- \*\* -- it is high and power consumption also has heavily the problem of being high.

[0004] Moreover, liquid crystal displays, such as an active-matrix drive, are commercialized as a lightweight and efficient flat-panel display. However, the angle of visibility of a liquid crystal display is narrow, and since it is not spontaneous light, it has the trouble of not having sufficient response engine performance to that the power consumption of a back light is large, and the high-speed video signal of a high definition with which utilization will be expected from now on under an environment dark in a perimeter. Technical problems, like especially the thing for which the display of big screen size is manufactured is difficult, and the cost is high also occur.

[0005] Although there is possibility of the display using the light emitting diode as an alternative over this, too, a manufacturing cost is high and the technical problem to utilization is large as a display candidate of a low price who there are problems, like it is difficult to form the matrix structure of a light emitting diode on the substrate whose number is one, and replaces the Braun tube.

[0006] Organic electroluminescence devices (organic EL device) using an organic luminescent material as a flat-panel display which may solve many of these technical problems attract attention recently. That is, by using an organic

compound as a luminescent material, a speed of response is high-speed with spontaneous light, and implementation of a flat-panel display without an angle-of-visibility dependency is expected.

[0007] The configuration of organic electroluminescence devices forms the organic thin film containing the luminescent material which emits light by impregnation of a current between the positive electrode of translucency, and metal cathode. C. W.Tang, S.A.VanSlyke, etc. In the research report of the 51st-volume No. 12 Applied Physics Letters 913-915-page (1987) printing The component structure which emits light when the hole and electron which were poured in into the organic film from each electrode recombine an organic thin film as two-layer structure of the thin film which consists of an electron hole transportability ingredient, and the thin film which consists of an electronic transportability ingredient was developed (organic EL device of single hetero structure).

[0008] With this component structure, either the electron hole transportation ingredient or the electronic transportation ingredient serves as luminescent material, and luminescence occurs by the wavelength range corresponding to the energy gap of the ground state and excitation state of luminescent material. By considering as such two-layer structure, reduction of large driver voltage and an improvement of luminous efficiency were made.

[0009] Then, C.Adachi, S.Tokita, T.Tsutsui, S.Saito etc. As indicated by the research report of Japanese Journal of Applied Physics volume [ 27th ] No. 2 L269-L 271-page (1988) printing The three-tiered structure (organic EL device of double hetero structure) of an electron hole transportation ingredient, luminescent material, and an electronic transportation ingredient is developed. Furthermore, C.W.Tang, S.A.VanSlyke, C.H.Chen, etc. Journal of Applied Physics As indicated by the research report of the 65th-volume No. 9 3610-3616-page (1989) printing The component structure where luminescent material was included in the electronic transportation ingredient etc. was developed. By these researches, by the low battery, the possibility of luminescence of high brightness is verified and researches and developments are done very actively in recent years.

[0010] It can be said that there is an organic compound used for luminescent material about the advantage that the luminescent color is theoretically changeable into arbitration by changing the molecular structure from the versatility. Therefore, it can be said to be easy by performing a molecular design compared with the thin film EL element which used the inorganic substance to arrange three good colors of R (red), G (green), and B (blue) of color purity required for a full color display.

[0011]

[Problem(s) to be Solved by the Invention] However, also in organic electroluminescence devices, there is a problem which must be solved in fact. As an electronic transportation ingredient by which is difficult for development of the stable red light emitting device of high brightness, and the current report is carried out tris (eight quinolinol) aluminum (the following, Alq3, and an abbreviated name --) Also in the example (Chem.Funct.Dyes, Proc.Int.Symp., 2nd P.536 (1993)) of red luminescence which doped DCM [a 4-dicyanomethylene-6-(p-dimethylaminostyryl)-2-methyl-4H-pyran] etc. The highest brightness, The satisfaction as a display ingredient of dependability does not go.

[0012] Moreover, T.Tsutsui and D.U.Kim Inorganic and Organic electroluminescence BSB-BCN reported at the meeting (1996 Berlin) is 1000 cd/m<sup>2</sup>. Although the above high brightness is realized, it cannot be said to be what has a perfect chromaticity as red which corresponds in full color.

[0013] The present condition is that implementation of stability and the high red light emitting device of color purity is furthermore desired by high brightness.

[0014] Moreover, in JP,7-188649,A (Japanese Patent Application No. No. 148798 [ six to ]), although it has proposed using a specific JISUCHIRIRU compound as an organic electroluminescence ingredient, the target luminescent color is blue and it is not an object for red. on the other hand, a hole and an



electron join together efficiently in a luminous layer by [ of a hole and an electron / energy ] shutting up and making structure in the laminated structure of organic electroluminescence devices, and it is reported that pure luminescence original with high brightness and luminescent material can be obtained -- \*\*\*\* (JP,10-79297,A, JP,11-204258,A, JP,11-204264,A, JP,11-204259,A, etc.) -- the target luminescent color is blue too and is not an object for red.

[0015] The purpose of this invention is to offer the organic electroluminescence devices which have high brightness and stable red luminescence. The second purpose of this invention promotes the hole in a luminous layer, and electronic recombination in the organic electroluminescence devices containing the compound which has a quantum yield high originally, and is to offer the organic electroluminescence devices which present further high brightness and efficient luminescence.

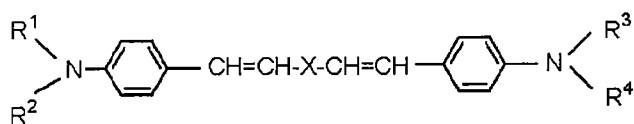
[0016]

[Means for Solving the Problem] In order that this invention may solve the above-mentioned technical problem, as a result of inquiring wholeheartedly, a header and this invention are reached [ that the stable full color display implementation of high brightness can be provided with a red light emitting device with very useful high dependability, and ] by using a specific JISUCHIRIRU compound as a luminescent material.

[0017] That is, the organic layer which has a luminescence field is prepared between an anode plate and cathode, and this invention requires it for the organic electroluminescence devices characterized by the thing of the JISUCHIRIRU compound expressed with said organic layer by the following general formula (1) included for a kind as an organic luminescent material at least in the organic electroluminescence devices which contain as a component the organic substance which emits light by impregnation of a current.

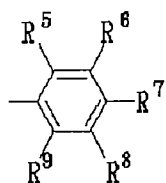
[0018]

[Formula 14] General formula (1) :

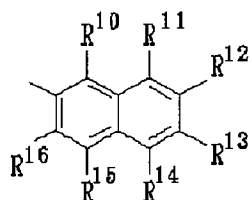


[ -- however, said general formula (1) -- setting -- R1, R2, R3, and R4 -- mutual -- identitas -- or the aryl group as which it is a different radical, and is the aryl group as which at least one of them is expressed in the following general formula (2), and at least one of them is expressed in the following general formula (3) or (4) -- it is -- [Formula 15]

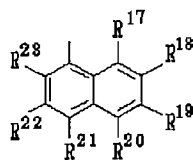
一般式(2) :



一般式 (3) :



一般式 (4) :

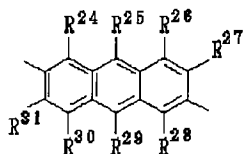


said general formula (2), (3), and (4) -- setting -- R5 and R6 -- [ however, ] R7, R8, R9, and R10, R11, R12, R13, R14, R15, R16, R17, R18, R19, R20, R21, R22 and R23 are radicals which are identical mutually or are different. Hydrogen atoms or those at least one Saturation or a partial saturation alkoxyl group (a carbon number preferably 1-24, further thing of 1-10), they are the aryl group which is not permuted [ permutations, such as an amino group, an alkylamino radical (a carbon number preferably 1-24, further thing of 1-10), or a phenyl group, or ], or a hydroxyl group.

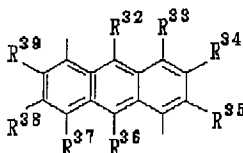
X is an aryl group which is not permuted [ the permutation expressed with the following general formula (5) or (6), or ].

[Formula 16]

一般式 (5) :



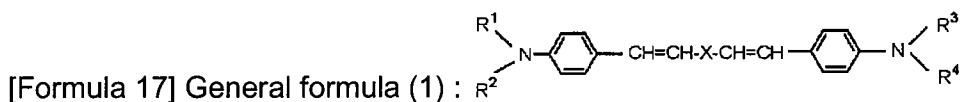
一般式 (6) :



(However, in said general formula (5) and (6), R<sup>24</sup>, R<sup>25</sup>, R<sup>26</sup>, R<sup>27</sup>, R<sup>28</sup>, R<sup>29</sup>, R<sup>30</sup>, R<sup>31</sup>, R<sup>32</sup>, R<sup>33</sup>, R<sup>34</sup>, R<sup>35</sup>, R<sup>36</sup>, R<sup>37</sup>, R<sup>38</sup>, and R<sup>39</sup> are identities or a different radical mutually, and are halogen (following, the same) atoms, such as a hydrogen atom, a cyano group, a nitro group, or F, Cl.) ]

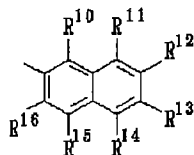
[0019] Moreover, this invention also offers the organic electroluminescence devices characterized by the thing of the JISUCHIRIRU compound expressed with said organic layer by the following general formula (1) included for a kind as an organic luminescent material at least in the organic electroluminescence devices by which the organic layer which has a luminescence field is prepared between an anode plate and cathode.

[0020]

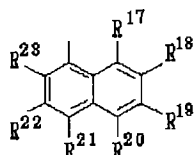


[ -- however, said general formula (1) -- setting -- R1, R2, R3, and R4 -- mutual --  
 identitas -- or the aryl group which is a different radical and is expressed with the  
 following general formula (3) or (4) -- it is -- [Formula 18]

一般式 (3) :



一般式 (4) :

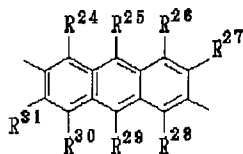


(However, in said general formula (3) and (4), R10, R11, R12, R13, R14, R15,  
 R16, R17, R18, R19, R20, R21, R22, and R23 are radicals which are identitas  
 mutually or are different.) they are the aryl group which is not permuted  
 [ permutations, such as a hydrogen atom, saturation or a partial saturation  
 alkoxyl group, an amino group, an alkylamino radical, and a phenyl group, or ] or  
 a hydroxyl group the same with having described above.

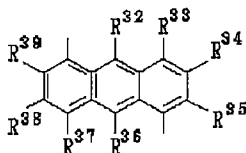
X is an aryl group which is not permuted [ the permutation expressed with the  
 following general formula (5) or (6), or ].

[Formula 19]

一般式 (5) :



一般式 (6) :



(However, in said general formula (5) and (6), R<sup>24</sup>, R<sup>25</sup>, R<sup>26</sup>, R<sup>27</sup>, R<sup>28</sup>, R<sup>29</sup>, R<sup>30</sup>, R<sup>31</sup>, R<sup>32</sup>, R<sup>33</sup>, R<sup>34</sup>, R<sup>35</sup>, R<sup>36</sup>, R<sup>37</sup>, R<sup>38</sup>, and R<sup>39</sup> are radicals which are identitas mutually or are different, and are a hydrogen atom, a cyano group, a nitro group, or a halogen atom.) ]

[0021] While stable red luminescence is obtained by high brightness by using the JISUCHIRIRU compound of the above-mentioned general formula (1) for luminescent material, the component which was chemically [ electrically, thermally, or ] excellent in stability can be offered. Although the JISUCHIRIRU compound expressed with the above-mentioned general formula (1) can be used independently, respectively, you may use together.

[0022] The JISUCHIRIRU compound used for the organic electroluminescence devices of this invention is explained.

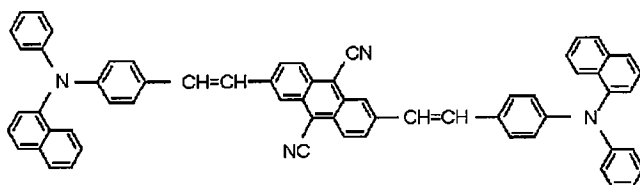
[0023] In the organic electroluminescence devices of this invention, the

JISUCHIRIRU compound shown by the general formula (1) which is luminescent material has at least one usable sort of the molecular structure like following structure-expression (7)-1, (7)-2, (7)-3, (7)-4, (7)-5, (7)-6, (7)-7, (7)-8, or (7)-9.

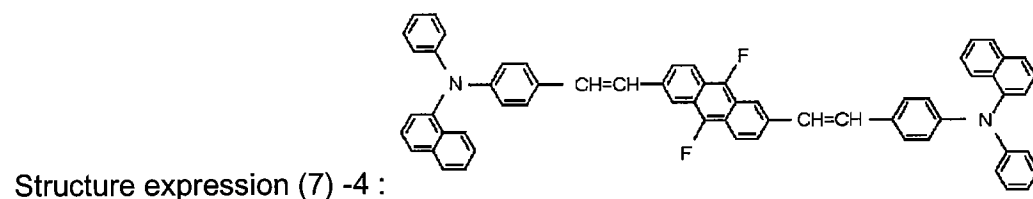
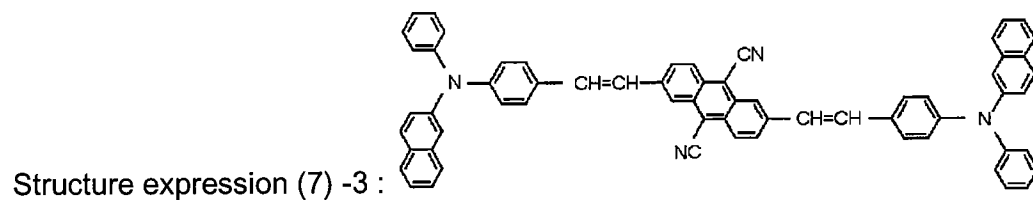
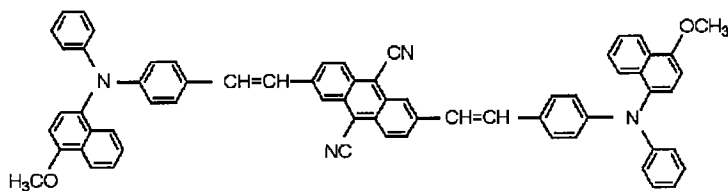
Each of these is bis(amino styryl) anthracene compounds which have an alkoxy (or alkyl) aryl group or a non-permuted aryl group.

[0024]

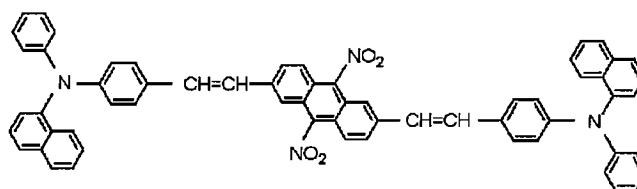
[Formula 20] Structure expression (7) -1 :



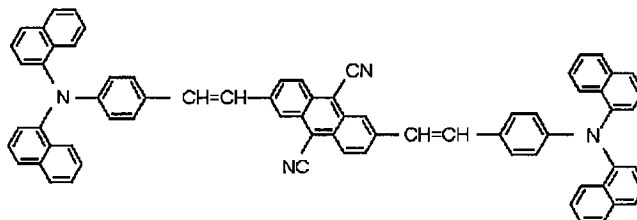
Structure expression (7) -2 :



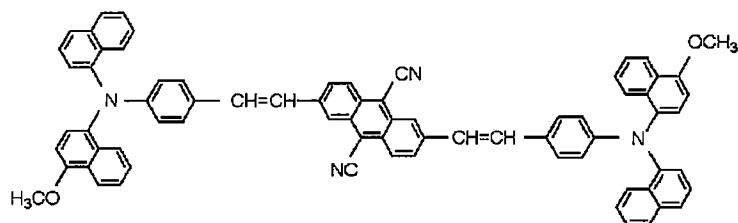
Structure expression (7) -5 :



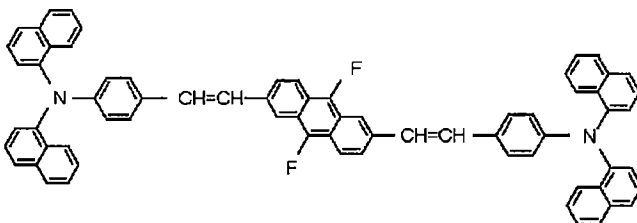
Structure expression (7) -6 :



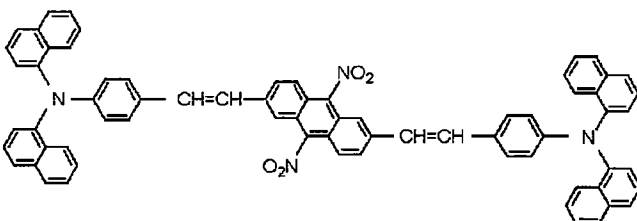
Structure expression (7) -7 :



Structure expression (7) -8 :



Structure expression (7) -9 :



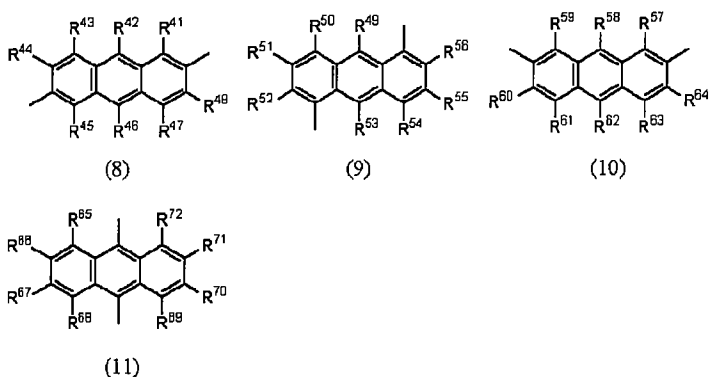


[0025] In order to solve the above-mentioned technical problem, as a result of inquiring wholeheartedly again, this invention person used to produce the organic electroluminescence devices which constituted the luminous layer from a specific styryl compound and an ingredient which can transmit energy to it efficiently, and used to reach this invention which offers the red light emitting device of high brightness and high-reliability further.

[0026] That is, the organic layer which has a luminescence field is prepared between an anode plate and cathode, and this invention requires at least one layer in said organic layer for the organic electroluminescence devices characterized by being the layer which consists of a styryl compound shown by the following general formula [I] in the organic electroluminescence devices which contain as a component the organic substance which emits light by impregnation of a current.

[Formula 21] General formula [I] :  $Y^1-CH=CH-X^1-CH=CH-Y^2$

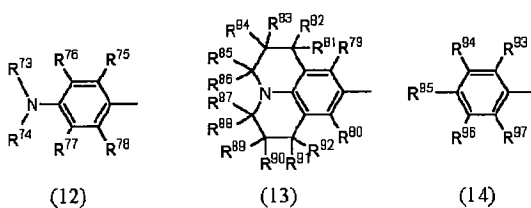
It is the radical as which X1 is expressed in following general formula (8) - (11) in [, however said general formula [I], and is [Formula 22].



(However, in each of R41-R48 in said general formula (8) - (11), R49-R56, R57-R64, and R65-R72, at least one is the radical chosen from the halogen atom, the nitro group, the cyano group, and the trifluoromethyl radical, and others are the radicals chosen from a hydrogen atom, an alkyl group, an aryl group, an alkoxy group, the halogen atom, the nitro group, the cyano group, and the trifluoromethyl radical.) Moreover, they may be the same or may differ.

Moreover, Y1 and Y2 are the radicals chosen from the following general formula (12), (13), and (14).

[Formula 23]



(However, R73 and R74 in said general formula (12) - (14) are the radical chosen from the hydrogen atom, the alkyl group which may have a substituent,

and the aryl group which may have a substituent, and its they may be the same or they may differ.) Moreover, R75-R97 are the radicals chosen from a hydrogen atom, the alkyl group which may have a substituent, the aryl group which may have a substituent, the alkoxy group which may have a substituent, the halogen atom, the nitro group, the cyano group, and the trifluoromethyl radical, and its they may be the same or they may differ.]

[0027] Moreover, in the organic electroluminescence devices containing the compound of above-mentioned this invention which has a quantum yield high originally, by putting a hole (electron hole) blocking layer on the cathode side of a luminous layer, recombination of a hole and an electron is efficiently performed in a luminous layer, and this invention comes to offer the organic electroluminescence devices from which pure luminescence original with luminescent material is obtained high brightness and efficient.

[0028] That is, this invention relates to the organic electroluminescence devices to which a hole (electron hole) blocking layer exists in the cathode side of the organic layer which consists of a styryl compound in which at least one layer of said organic layer is shown by said general formula [I], and contains said styryl compound in the organic electroluminescence devices by which the organic layer which has a luminescence field is prepared between an anode plate and cathode again.

[0029] For example, in contact with the cathode side of the layer which said organic layer is having the organic laminated structure to which the laminating of a hole transportation layer and the electron transport layer was carried out, and consisted of styryl compounds of said organic layers in which an electron transport layer is shown by said general formula [I] at least, and consisted of said styryl compounds, said hole (electron hole) blocking layer may exist.

[0030] Moreover, said hole blocking layer may exist in contact with the cathode side of the layer which said organic layer is having the organic laminated structure to which the laminating of a hole transportation layer and the electron transport layer was carried out, and consisted of styryl compounds of said organic layers in which a hole transportation layer is shown by said general formula [I] at least, and consisted of said styryl compounds.

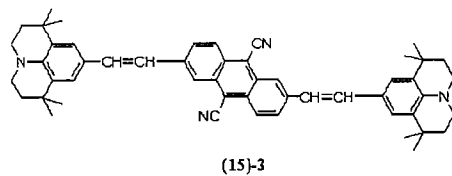
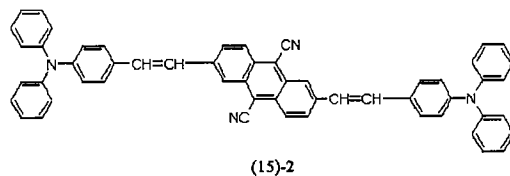
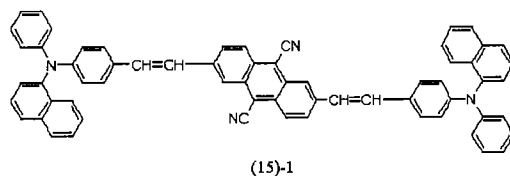
[0031] Moreover, it consists of styryl compounds in which said organic layer is having the organic laminated structure to which the laminating of a hole transportation layer and the electron transport layer was carried out, and it consists of styryl compounds in which said hole transportation layer is shown by said general formula [I], and said electron transport layer is shown by said general formula [I], and said hole blocking layer may exist in contact with the cathode side of the electronic transportability luminescence layer of a parenthesis.

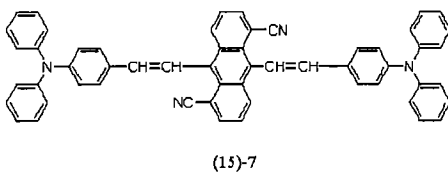
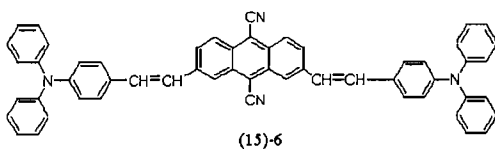
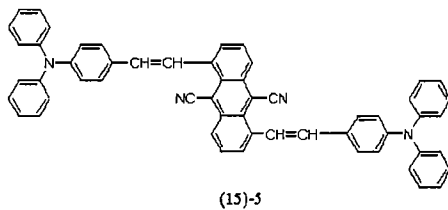
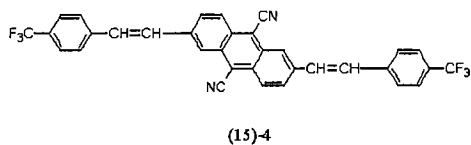
[0032] Moreover, said hole blocking layer may exist in contact with the cathode side of the layer which said organic layer is having the organic laminated structure to which the laminating of a hole transportation layer, a luminous layer, and the electron transport layer was carried out, and consisted of styryl compounds of said organic layers in which a luminous layer is shown by said general formula [I] at least, and consisted of said styryl compounds.

[0033] In the organic electroluminescence devices of this invention, even if there is little molecular structure like following structure-expression (15)-1-(15)-7 as a styryl compound shown by the general formula [I], a kind is usable.

[0034]

[Formula 24]





[0035] Moreover, it is desirable for the ingredient suitable for a hole blocking layer to be what has the following energy states. Namely, the thing in energy level with the highest occupancy molecular-orbital level of the ingredient which forms a hole blocking layer lower than the highest occupancy molecular-orbital level of the ingredient which forms the layer which touches the anode plate side of a hole blocking layer, And the minimum non-occupying molecular-orbital level of the ingredient which forms a hole blocking layer It is being in energy level lower than the minimum non-occupying molecular-orbital level of the ingredient

which forms the layer which is in energy level higher than the minimum non-occupying molecular-orbital level of the ingredient which forms the layer which touches the anode plate side of a hole blocking layer, and touches the cathode side of a hole blocking layer.

[0036] Although the phenanthroline derivative shown in JP,10-79297,A, JP,11-204258,A, JP,11-204264,A, JP,11-204259,A, etc. is mentioned as such an ingredient, if the conditions of the above-mentioned energy level are fulfilled, it will not be limited to a phenanthroline derivative.

[0037] The example of organic electroluminescence devices based on this invention is shown in drawing 1 - drawing 4 and drawing 5 - drawing 8 , respectively.

[0038] Drawing 1 is the transparency mold organic electroluminescence devices A to which the luminescence light 20 penetrates cathode 3, and luminescence 20 can be observed also from a protective layer 4 side. Drawing 2 shows the reflective mold organic electroluminescence devices B which also obtain the reflected light in cathode 3 as a luminescence light 20.

[0039] Among drawing, one is a substrate for forming organic electroluminescence devices, and can use glass, plastics, and other proper ingredients. Moreover, a substrate can also be shared when using organic electroluminescence devices combining other display devices. 2 -- a transparent

electrode (anode plate) -- it is -- ITO (Indium tin oxide) and SnO<sub>2</sub> etc. -- it can be used.

[0040] Moreover, 5 is an organic luminous layer and contains the above-mentioned styryl compound as a luminescent material. About this luminous layer, well-known various configurations can be conventionally used as lamination which obtains organic electroluminescence 20. When the ingredient which constitutes an electron hole transportation layer or an electron transport layer has a luminescence so that it may mention later for example, the structure which carried out the laminating of these thin films can be used. Furthermore, in order to raise charge transportability ability in the range which fills the purpose of this invention, both an electron hole transportation layer, and both [ either or ] bar using the structure which carried out the laminating of the thin film of two or more sorts of ingredients, or the thin film which consists of a presentation which mixed two or more sorts of ingredients. Moreover, in order to improve the luminescence engine performance, the ingredient of at least one or more sorts of fluorescence may be used, and the structure which pinched this thin film between the electron hole transportation layer and the electron transport layer, and the structure where the ingredient of at least one or more sorts of fluorescence was further included in an electron hole transportation layer, electron transport layers, or these both may be used. In order to improve luminous efficiency in these cases,



it is also possible to include the thin film for controlling transportation of an electron hole or an electron in the lamination.

[0041] Since the JISUCHIRIRU compound illustrated with the above-mentioned structure expression (7) has both electronic transportability ability and electron hole transportability ability, it can be used during a component configuration also as a luminous layer which served as the electron hole transportation layer also as a luminous layer which served both as the electron transport layer. Moreover, it is also possible to consider as the configuration put in the electron transport layer and the electron hole transportation layer by making this JISUCHIRIRU compound into a luminous layer. In addition to the above-mentioned configuration, drawing 5 and drawing 6 form the hole blocking layer 21 which consists of a phenanthroline derivative in contact with the cathode side of a luminous layer 5.

[0042] In addition, among drawing 1 and drawing 2 , drawing 5 , and drawing 6 , three are cathode and can use the alloy of a metal [ activity / calcium / Li, Mg, ] and metals, such as Ag, aluminum, and In, or the structure which carried out the laminating of these as an electrode material. In the organic electroluminescence devices of a transparency mold, the light transmittance suitable for an application can be obtained by adjusting the thickness of cathode. Moreover, four in drawing is the closure and a protective layer, and the effectiveness goes

up it by making the organic whole electroluminescence devices into wrap structure. A proper ingredient can be used if airtightness is maintained. Moreover, 8 is a drive power source for current impregnation.

[0043] In the organic electroluminescence devices based on this invention, the organic layer has the organic laminated structure (single hetero structure) to which the laminating of an electron hole transportation layer and the electron transport layer was carried out, and said styryl compound may be used as a formation ingredient of an electron hole transportation layer or an electron transport layer. Or the organic layer has the organic laminated structure (double hetero structure) to which the laminating of an electron hole transportation layer, a luminous layer, and the electron transport layer was carried out one by one, and said styryl compound may be used as a formation ingredient of a luminous layer.

[0044] When the example of the organic electroluminescence devices which have such an organic laminated structure is shown, drawing 3 has the laminated structure to which the laminating of organic layer 5a which consists of an anode plate 2, and the electron hole transportation layer 6 and electron transport layer 7 of translucency on the substrate 1 of translucency, and the cathode 3 was carried out one by one, and is the organic electroluminescence devices C of the single hetero structure where a protective coat 4 comes to carry out the closure

of this laminated structure. In drawing 7 , the hole blocking layer 21 is formed in contact with the cathode side of an electron transport layer 7 and/or the electron hole transportation layer 6.

[0045] In the case of the lamination which omitted the luminous layer as shown in drawing 3 and drawing 7 , the luminescence 20 of predetermined wavelength is generated from the interface of the electron hole transportation layer 6 and an electron transport layer 7. These luminescence is observed from a substrate 1 side.

[0046] Moreover, drawing 4 has the laminated structure to which the laminating of organic layer 5b which consists of an anode plate 2, and the electron hole transportation layer 10, the luminous layer 11 and electron transport layer 12 of translucency on the substrate 1 of translucency, and the cathode 3 was carried out one by one, and is the organic electroluminescence devices D of the double hetero structure where a protective coat 4 comes to carry out the closure of this laminated structure. In drawing 8 , the hole blocking layer 21 is formed in contact with the cathode side of a luminous layer 11.

[0047] In the organic electroluminescence devices shown in drawing 4 and drawing 8 , the electron with which the electron hole poured in from the anode plate 2 was poured in from cathode 3 through the electron hole transportation layer 10 reaches a luminous layer 11 through an electron transport layer 12,

respectively by impressing direct current voltage between an anode plate 2 and cathode 3. Consequently, the recombination of an electron/electron hole arises in a luminous layer 11, a singlet exciton generates, and luminescence of predetermined wavelength is generated from this singlet exciton.

[0048] In each organic electroluminescence devices C and D mentioned above, the ingredient of light transmission nature, such as glass and plastics, can be suitably used for a substrate 1. Moreover, when using combining other display devices, or when arranging the laminated structure shown in drawing 3 and drawing 4 , drawing 7 , and drawing 8 in the shape of a matrix, it is good considering this substrate as common use. Moreover, Components C and D can all take any structure of a transparency mold and a reflective mold.

[0049] moreover, the anode plate 2 -- a transparent electrode -- it is -- ITO (indium tin oxide) and SnO<sub>2</sub> etc. -- it can be used. Between this anode plate 2 and the electron hole transportation layer 6 (or electron hole transportation layer 10), the thin film which consists of the organic substance or an organometallic compound may be prepared in order to improve the injection efficiency of a charge. In addition, when the protective coat 4 is formed with conductive ingredients, such as a metal, the insulator layer may be prepared in the side face of an anode plate 2.

[0050] Moreover, the electron hole transportation layer 6 and an electron

transport layer 7 are organic layers by which the laminating was carried out, the styryl compound described above to these either or both sides contains organic layer 5a in the organic electroluminescence devices C, and it is good as the luminescent electron hole transportation layer 6 or a luminescent electron transport layer 7. Organic layer 5b in the organic electroluminescence devices D can take various laminated structures, although the electron hole transportation layer 10, the luminous layer 11 containing the above-mentioned styryl compound, and an electron transport layer 12 are organic layers by which the laminating was carried out. For example, both the electron hole transportation layer, and both [ either or ] may have a luminescence.

[0051] Moreover, although it is desirable that it is the layer which the electron hole transportation layer 6 or an electron transport layer 7, and a luminous layer 11 turn into from the styryl compound of this invention especially, these layers may be formed only with said styryl compound, or you may form by said styryl compound, other electron holes, or vapor codeposition with electronic transportation ingredients (for example, aromatic amine and pyrazolines etc.). Furthermore, in an electron hole transportation layer, in order to raise electron hole transportability ability, the electron hole transportation layer which carried out the laminating of two or more sorts of electron hole transportation ingredients may be formed.

[0052] Moreover, in the organic electroluminescence devices C, although a luminous layer may be the electronic transportability luminous layer 7, depending on the electrical potential difference impressed from a power source 8, light may be emitted by the electron hole transportation layer 6 or its interface. Similarly, in the organic electroluminescence devices D, a luminous layer may be an electron transport layer 12 in addition to layer 11, and may be the electron hole transportation layer 10. In order to raise the luminescence engine performance, it is good that it is the structure where the luminous layer 11 which used at least one sort of fluorescence ingredients was made to pinch between an electron hole transportation layer and an electron transport layer. Or the structure where an electron hole transportation layer, an electron transport layer, or both [ these ] layers were made to contain this fluorescence ingredient may be constituted. In such a case, in order to improve luminous efficiency, it is also possible to include the thin films (a hole blocking layer, exciton generation layer, etc.) for controlling transportation of an electron hole or an electron in the lamination.

[0053] Moreover, you may be the structure in which could use the alloy of a metal [ activity / calcium / Li, Mg, ] and metals, such as Ag, aluminum, and In, as an ingredient used for cathode 3, and these metal layers carried out the laminating. In addition, the organic electroluminescence devices corresponding

to an application are producible by choosing the thickness and the quality of the material of cathode suitably.

[0054] Moreover, a protective coat 4 acts as closure film, is making the organic whole electroluminescence devices into wrap structure, and can improve charge injection efficiency and luminous efficiency. In addition, if the airtightness is maintained, a single metal or alloys, such as aluminum, gold, and chromium, etc. can choose the ingredient suitably.

[0055] Although the current impressed to each above-mentioned organic electroluminescence devices is usually a direct current, pulse current and an alternating current may be used. If a current value and an electrical-potential-difference value are within the limits which does not carry out component destruction, there will be especially no limit, but when the power consumption and the life of organic electroluminescence devices are taken into consideration, it is desirable to make light emit efficiently with as small electrical energy as possible.

[0056] Next, drawing 9 is the example of a configuration of the flat-surface display which used the organic electroluminescence devices of this invention. In the full color display, like illustration, red (R) and the green organic layer 5 (5a, 5b) which can emit light in the three primary colors of (G) and blue (B) are allotted between cathode 3 and an anode plate 2. It can prepare in the shape of

[ which crosses mutually ] a stripe, it is chosen by the luminance-signal circuit 14 and the control circuit 15 with a built-in shift register, and a signal level is impressed to each, and cathode 3 and an anode plate 2 are constituted so that the organic layer of the location (pixel) where the cathode 3 and the anode plate 2 which were chosen by this cross may emit light.

[0057] That is, it is a 8x3RGB simple matrix, and drawing 9 arranges the layered product 5 which consists of one side between cathode 3 and an anode plate 2, even if there are few electron hole transportation layers, and luminous layers and electron transport layers either (refer to drawing 3 and drawing 7 or drawing 4 , and drawing 8 ). Both cathode and an anode plate are made to intersect perpendicularly in the shape of a matrix mutually, impress a signal level serially by the control circuits 15 and 14 with a built-in shift register, and they are constituted so that light may be emitted in the decussation location, while carrying out patterning to the shape of a stripe. Of course, the EL element of this configuration can be used also as picture reproducer as a display of an alphabetic character, a notation, etc. Moreover, the stripe-like pattern of cathode 3 and an anode plate 2 is arranged for every color of red (R), green (G), and blue (B), and it becomes possible to constitute multicolor or all full color solid-state mold flat-panel displays.

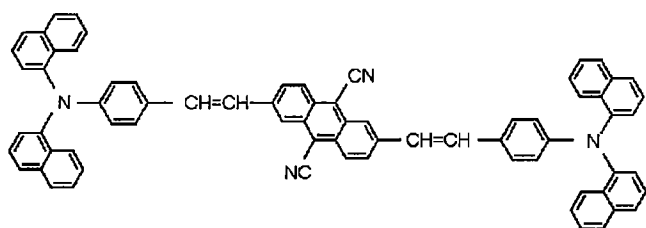
[0058]



[Example] Hereafter, although this invention is concretely explained about an example, this invention is not limited to the following examples.

[0059] Example 1 this example is R1 among the above-mentioned JISUCHIRIRU compounds of a general formula (1), R2, and R3 and R4. It is the example which produced the organic electroluminescence devices of single hetero structure, using the compound (2, the 6-screw (styryl dinaphthylamino) -9, 10-dicyano anthracene) of following structure-expression (7)-6 which had 9 and 10-dicyano anthracene radical for the non-permuted naphthyl group in X as an electron hole transportability luminescent material.

[Formula 25] Structure expression (7) -6 :



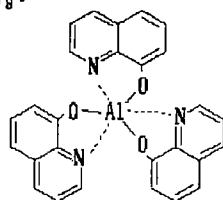
[0060] First, the 30mmx30mm glass substrate with which the anode plate which consists of ITO with a thickness of 100nm was formed on one front face into the vacuum evaporation system was set. The substrate was approached, the metal mask which has two or more 2.0mmx2.0mm unit openings as a vacuum evaporation mask has been arranged, and the compound of above-mentioned structure-expression (7)-6 was formed as an electron hole transportation layer

(\*\*\*\*\*) in thickness of 50nm under the vacuum of  $10^{-4}$  or less Pa with the vacuum deposition method. The vacuum evaporation rate was carried out in 0.1nm/second.

[0061] Furthermore, Alq<sub>3</sub> (tris (eight quinolinol) aluminum) of the following structure expression was vapor-deposited in contact with the electron hole transportation layer as an electronic transportation ingredient. Alq<sub>3</sub> from -- thickness of this becoming electron transport layer was also set to 50nm, and the vacuum evaporation rate was carried out in 0.2nm/second.

[Formula 26]

Alq<sub>3</sub> :



[0062] The cascade screen of Mg and Ag was adopted as a cathode material, and by vacuum evaporation, this was also formed in the thickness of 50nm (Mg film) and 150nm (Ag film) as vacuum evaporation rate 1nm/a second, and produced the \*\*\*\* organic electroluminescence devices shown in drawing 3 by the example 1.

[0063] Thus, forward bias direct current voltage was applied to the organic electroluminescence devices of the produced example 1 under

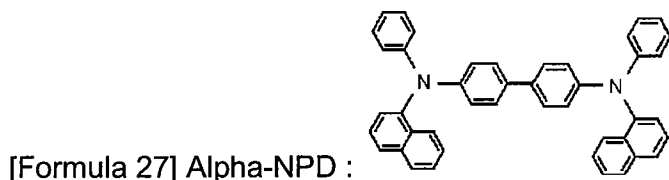
nitrogen-gas-atmosphere mind, and the luminescence property was evaluated. The luminescent color was red, and as a result of performing spectrometry, as shown in drawing 10 , it obtained the spectrum which has a luminescence peak in 705nm. The spectroscopy which used the photodiode array by the Otsuka electronic company as the detector was used for spectrometry. Moreover, when the electrical-potential-difference-measurement of luminance is performed, as it is shown in drawing 11 , they are 150 cd/m<sup>2</sup> at 8.5V. Brightness was obtained.

[0064] After producing these organic electroluminescence devices, although it was left for one month under nitrogen-gas-atmosphere mind, component degradation was not observed. Moreover, initial brightness 100 cd/m<sup>2</sup> The current value was energized uniformly and continuation luminescence was carried out, and when carrying out forcible degradation, it was 100 hours until brightness was halved.

[0065] Example 2 this example is R1 among the above-mentioned JISUCHIRIRU compounds of a general formula (1), R2, and R3 and R4. It is the example which produced the organic electroluminescence devices of single hetero structure, using the compound of above-mentioned structure-expression (7)-6 which had 9 and 10-dicyano anthracene radical for the non-permuted naphthyl group in X as an electronic transportability luminescent material.

[0066] First, the 30mmx30mm glass substrate with which the anode plate which

consists of ITO with a thickness of 100nm was formed on one front face into the vacuum evaporation system was set. The substrate was approached, the metal mask which has two or more 2.0mmx2.0mm unit openings as a vacuum evaporation mask has been arranged, and alpha-NPD (alpha-naphthylphenyl diamine) of the following structure expression was formed as an electron hole transportation layer in thickness of 50nm under the vacuum of  $10^{-4}$  or less Pa with vacuum evaporation technique. The vacuum evaporation rate was carried out in 0.1nm/second.



[0067] Furthermore, the compound of above-mentioned structure-expression (7)-6 was vapor-deposited in contact with the electron hole transportation layer as an electronic transportation ingredient. The above-mentioned structure expression (7) Thickness of the electron transport layer (\*\*\*\*\*) which consists of a compound of -6 was also set to 50nm, and the vacuum evaporation rate was carried out in 0.2nm/second.

[0068] The cascade screen of Mg and Ag was adopted as a cathode material, and by vacuum evaporation, this was also formed in the thickness of 50nm (Mg film) and 150nm (Ag film) as vacuum evaporation rate 1nm/a second, and

produced the \*\*\*\* organic electroluminescence devices shown in drawing 3 by the example 2.

[0069] Thus, forward bias direct current voltage was applied to the organic electroluminescence devices of the produced example 2 under nitrogen-gas-atmosphere mind, and the luminescence property was evaluated. The luminescent color was red, and as a result of performing spectrometry like an example 1, as shown in drawing 12 , it obtained the spectrum which has a luminescence peak in 705nm. Moreover, when the electrical-potential-difference-measurement of luminance is performed, as it is shown in drawing 13 , they are 170 cd/m<sup>2</sup> at 8.5V. Brightness was obtained.

[0070] After producing these organic electroluminescence devices, although it was left for one month under nitrogen-gas-atmosphere mind, component degradation was not observed. Moreover, initial brightness 100 cd/m<sup>2</sup> The current value was energized uniformly and continuation luminescence was carried out, and when carrying out forcible degradation, it was 110 hours until brightness was halved.

[0071] Example 3 this example is R1 among the above-mentioned JISUCHIRIRU compounds of a general formula (1), R2, and R3 and R4. It is the example which produced the organic electroluminescence devices of double hetero layer structure, using the compound of above-mentioned

structure-expression (7)-6 which had 9 and 10-dicyano anthracene radical for the non-permuted naphthyl group in X as a luminescent material.

[0072] First, the 30mmx30mm glass substrate with which the anode plate which consists of ITO with a thickness of 100nm was formed on one front face into the vacuum evaporation system was set. The substrate was approached, the metal mask which has two or more 2.0mmx2.0mm unit openings as a vacuum evaporation mask has been arranged, and alpha-NPD of the above-mentioned structure expression was formed as an electron hole transportation layer in thickness of 30nm under the vacuum of  $10^{-4}$  or less Pa with the vacuum deposition method. The vacuum evaporation rate was carried out in 0.2nm/second.

[0073] Furthermore, the compound of above-mentioned structure-expression (7)-6 was vapor-deposited in contact with the electron hole transportation layer as a luminescent material. The above-mentioned structure expression (7) Thickness of the luminous layer which consists of a compound of -6 was also set to 30nm, and the vacuum evaporation rate was carried out in 0.2nm/second.

[0074] Furthermore, it is Alq3 of the above-mentioned structure expression as an electronic transportation ingredient. It vapor-deposited in contact with the luminous layer. Alq3 Thickness was set to 30nm and the vacuum evaporation rate was carried out in 0.2nm/second.

[0075] The cascade screen of Mg and Ag was adopted as a cathode material, and by vacuum evaporation, this was also formed in the thickness of 50nm (Mg film) and 150nm (Ag film) as vacuum evaporation rate 1nm/a second, and produced the \*\*\*\* organic electroluminescence devices shown in drawing 4 by the example 3.

[0076] Thus, forward bias direct current voltage was applied to the organic electroluminescence devices of the produced example 3 under nitrogen-gas-atmosphere mind, and the luminescence property was evaluated. The luminescent color was red, and as a result of performing spectrometry, as shown in drawing 14 , it obtained the spectrum which has a luminescence peak in 705nm. When the electrical-potential-difference-measurement of luminance is performed, as it is shown in drawing 15 , they are 250 cd/m<sup>2</sup> at 8.5V. Brightness was obtained.

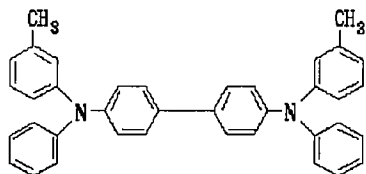
[0077] After producing these organic electroluminescence devices, although it was left for one month under nitrogen-gas-atmosphere mind, component degradation was not observed. Moreover, initial brightness 100 cd/m<sup>2</sup> The current value was energized uniformly and continuation luminescence was carried out, and when carrying out forcible degradation, it was 200 hours until brightness was halved.

[0078] Changed to alpha-NPD as an example 4 electron-hole transportability

ingredient, and TPD (triphenyl diamine derivative) of the following structure expression was used, and also lamination and the forming-membranes method produced organic electroluminescence devices based on the example 2.

[Formula 28]

TPD :

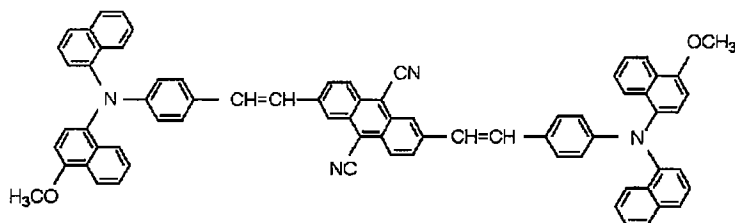


[0079] The organic electroluminescence devices of this example also presented luminescence of the same red as an example 2. The spectrum was in agreement with the spectrum of the organic electroluminescence devices of an example 2 as a result of spectrometry.

[0080] Example 5 this example is R1 among the above-mentioned JISUCHIRIRU compounds of a general formula (1). And R4 It is a non-permuted naphthyl group R2 And R3 It is the example which produced the organic electroluminescence devices of single hetero structure, using the compound of following structure-expression (7)-7 which had 9 and 10-dicyano anthracene radical for 4-methoxy naphthyl group in X as an electron hole transportability luminescent material.

[Formula 29] Structure expression (7) -7 :





[0081] First, the 30mmx30mm glass substrate with which the anode plate which consists of ITO with a thickness of 100nm was formed on one front face into the vacuum evaporation system was set. The substrate was approached, the metal mask which has two or more 2.0mmx2.0mm unit openings as a vacuum evaporation mask has been arranged, and the compound of above-mentioned structure-expression (7)-7 was formed as an electron hole transportation layer (\*\*\*\*\*) in thickness of 50nm under the vacuum of  $10^{-4}$  or less Pa with the vacuum deposition method. The vacuum evaporation rate was carried out in 0.1nm/second.

[0082] Furthermore, Alq3 (tris (eight quinolinol) aluminum) of the above-mentioned structure expression was vapor-deposited in contact with the electron hole transportation layer as an electronic transportation ingredient. Alq3 from -- thickness of this becoming electron transport layer was also set to 50nm, and the vacuum evaporation rate was carried out in 0.2nm/second.

[0083] The cascade screen of Mg and Ag was adopted as a cathode material, and by vacuum evaporation, this was also formed in the thickness of 50nm (Mg

film) and 150nm (Ag film) as vacuum evaporation rate 1nm/a second, and produced the \*\*\*\* organic electroluminescence devices shown in drawing 3 by the example 5.

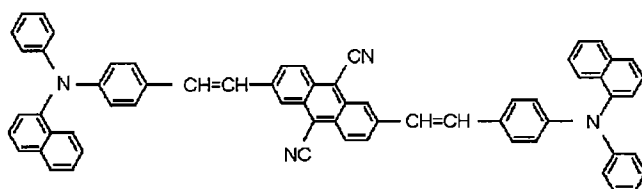
[0084] Thus, forward bias direct current voltage was applied to the organic electroluminescence devices of the produced example 5 under nitrogen-gas-atmosphere mind, and the luminescence property was evaluated. The luminescent color was red, and as a result of performing spectrometry, as shown in drawing 16 , it obtained the spectrum which has a luminescence peak in 720nm. The spectroscopy which used the photodiode array by the Otsuka electronic company as the detector was used for spectrometry. Moreover, when the electrical-potential-difference-measurement of luminance is performed, as it is shown in drawing 17 , they are 200 cd/m<sup>2</sup> at 8.5V. Brightness was obtained.

[0085] After producing these organic electroluminescence devices, although it was left for one month under nitrogen-gas-atmosphere mind, component degradation was not observed. Moreover, initial brightness 100 cd/m<sup>2</sup> The current value was energized uniformly and continuation luminescence was carried out, and when carrying out forcible degradation, it was 150 hours until brightness was halved.

[0086] Example 6 this example is R1 among the above-mentioned JISUCHIRIRU compounds of a general formula (1). And R4 It is a non-permuted

phenyl group R2 And R3 It is the example which produced the organic electroluminescence devices of single hetero structure, using the compound of following structure-expression (7)-1 which had 9 and 10-dicyano anthracene radical for the non-permuted naphthyl group in X as an electronic transportability luminescent material. Layer structure and the forming-membranes method produced organic electroluminescence devices based on the example 2.

[Formula 30] Structure expression (7) -1 :



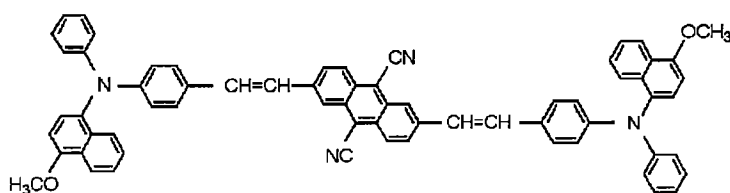
[0087] Thus, forward bias direct current voltage was applied to the organic electroluminescence devices of the produced example 6 under nitrogen-gas-atmosphere mind, and the luminescence property was evaluated.

The luminescent color was red, and as a result of performing spectrometry like an example 1, it obtained the spectrum which has a luminescence peak in 705nm. Moreover, when the electrical-potential-difference-measurement of luminance was performed, they are 200 cd/m<sup>2</sup> at 8V. Brightness was obtained.

[0088] After producing these organic electroluminescence devices, although it was left for one month under nitrogen-gas-atmosphere mind, component degradation was not observed.

[0089] Example 7 this example is R1 among the above-mentioned JISUCHIRIRU compounds of a general formula (1). And R4 It is a non-permuted phenyl group R2 And R3 It is the example which produced the organic electroluminescence devices of single hetero layer structure, using the compound of following structure-expression (7)-2 which had 9 and 10-dicyano anthracene radical for 4-methoxy naphthyl group in X as an electronic transportability ingredient. Layer structure and the forming-membranes method produced organic electroluminescence devices based on the example 2.

[Formula 31] Structure expression (7) -2 :



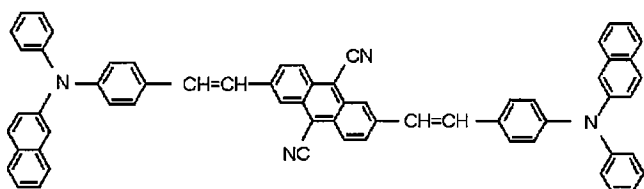
[0090] Thus, forward bias direct current voltage was applied to the organic electroluminescence devices of the produced example 7 under nitrogen-gas-atmosphere mind, and the luminescence property was evaluated. The luminescent color was red, and as a result of performing spectrometry, it obtained the spectrum which has a luminescence peak in 705nm. When the electrical-potential-difference-measurement of luminance was performed, they are 160 cd/m<sup>2</sup> at 8V. Brightness was obtained.

[0091] After producing these organic electroluminescence devices, although it

was left for one month under nitrogen-gas-atmosphere condition, component degradation was not observed.

[0092] Example 8 this example is R1 among the above-mentioned JISUCHIRIRU compounds of a general formula (1). And R4 It is a non-permuted phenyl group R2 And R3 It is the example which produced the organic electroluminescence devices of single hetero layer structure, using the compound of following structure-expression (7)-3 which had 9 and 10-dicyano anthracene radical for the non-permuted naphthyl group in X as an electronic transportability ingredient. Layer structure and the forming-membranes method produced organic electroluminescence devices based on the example 2.

[Formula 32] Structure expression (7) -3 :



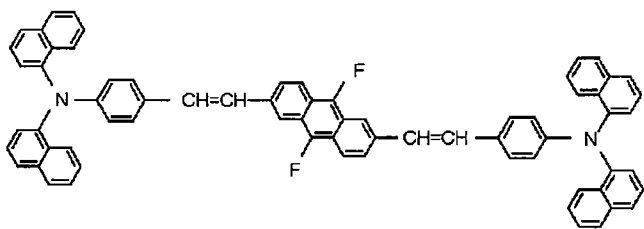
[0093] Thus, forward bias direct current voltage was applied to the organic electroluminescence devices of the produced example 8 under nitrogen-gas-atmosphere condition, and the luminescence property was evaluated. The luminescent color was red, and as a result of performing spectrometry, it obtained the spectrum which has a luminescence peak in 705nm. When the electrical-potential-difference-measurement of luminance was performed, they

are 90 cd/m<sup>2</sup> at 8V. Brightness was obtained.

[0094] After producing these organic electroluminescence devices, although it was left for one month under nitrogen-gas-atmosphere mind, component degradation was not observed.

[0095] Example 9 this example is R1 among the above-mentioned JISUCHIRIRU compounds of a general formula (1), R2, and R3 and R4. It is the example which produced the organic electroluminescence devices of single hetero layer structure, using the compound of following structure-expression (7)-8 which had 9 and 10-difluro anthracene radical for the non-permuted naphthyl group in X as an electronic transportability ingredient. Layer structure and the forming-membranes method produced organic electroluminescence devices based on the example 2.

[Formula 33] Structure expression (7) -8 :



[0096] Thus, forward bias direct current voltage was applied to the organic electroluminescence devices of the produced example 9 under nitrogen-gas-atmosphere mind, and the luminescence property was evaluated.

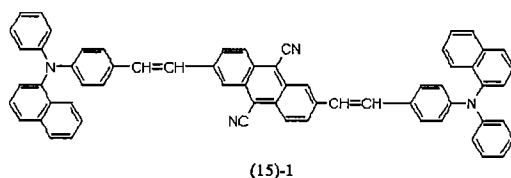
The luminescent color was red, and as a result of performing spectrometry, it obtained the spectrum which has a luminescence peak in 705nm. When the electrical-potential-difference-measurement of luminance was performed, they are 180 cd/m<sup>2</sup> at 8V. Brightness was obtained.

[0097] After producing these organic electroluminescence devices, although it was left for one month under nitrogen-gas-atmosphere condition, component degradation was not observed.

[0098] Example 10 this example is an example which produced the organic electroluminescence devices which used the compound of following structure-expression (15)-1 as an electron hole transportability luminous layer among the above-mentioned styryl compounds of a general formula [I].

[0099]

[Formula 34] Structure expression (15) -1 :



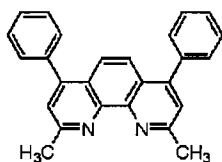
[0100] First, the 30mmx30mm glass substrate with which the anode plate which consists of ITO with a thickness of 100nm was formed on one front face into the vacuum evaporation system was set. The substrate was approached, the metal mask which has two or more 2.0mmx2.0mm unit openings as a vacuum

evaporation mask has been arranged, and the compound of above-mentioned structure-expression (15)-1 was formed as an electron hole transportation layer (\*\*\*\*\*) in thickness of 50nm under the vacuum of  $10^{-4}$  or less Pa with the vacuum deposition method. The vacuum evaporation rate was made respectively in 0.1nm/second.

[0101] Furthermore, the bathocuproine of the following structure expression was vapor-deposited in contact with the electron hole transportation layer as a hole blocking layer ingredient. The thickness of this hole blocking layer that consists of bathocuproine set to 15nm, and the vacuum evaporation rate was carried out in 0.1nm/second.

[0102] Furthermore, Alq3 (tris (eight quinolinol) aluminum) of the above-mentioned structure expression was vapor-deposited in contact with the hole blocking layer as an electron transport layer ingredient. Thickness of this electron transport layer that consists of Alq3 was also set to 50nm, and the vacuum evaporation rate was carried out in 0.2nm/second.

[0103]



[Formula 35] Bathocuproine :

[0104] The cascade screen of Mg and Ag was adopted as a cathode material,



and by vacuum evaporation, this was also formed in the thickness of 50nm (Mg film) and 150nm (Ag film) as vacuum evaporation rate 1nm/a second, and produced the \*\*\*\* organic electroluminescence devices shown in drawing 7 by the example 10.

[0105] Thus, forward bias direct current voltage was applied to the organic electroluminescence devices of the produced example 10 under nitrogen-gas-atmosphere mind, and the luminescence property was evaluated. The luminescent color was red, and as a result of performing spectrometry, it obtained the spectrum which has a luminescence peak near 710nm. The spectroscope which used the photodiode array by the Otsuka electronic company as the detector was used for spectrometry. Moreover, when the electrical-potential-difference-measurement of luminance was performed, the brightness of 200 cd/m<sup>2</sup> was obtained by 8V.

[0106] After producing these organic electroluminescence devices, although it was left for one month under nitrogen-gas-atmosphere mind, component degradation was not observed. Moreover, when energizing a current value uniformly, carrying out continuation luminescence and carrying out forcible degradation by initial brightness 50 cd/m<sup>2</sup>, it was 200 hours until brightness was halved.

[0107] Example 11 this example is an example which produced the organic

electroluminescence devices which used the compound of above-mentioned structure-expression (15)-1 as an electronic transportability luminous layer among the above-mentioned styryl compounds of a general formula [I].

[0108] First, the 30mmx30mm glass substrate with which the anode plate which consists of ITO with a thickness of 100nm was formed on one front face into the vacuum evaporation system was set. The substrate was approached, the metal mask which has two or more 2.0mmx2.0mm unit openings as a vacuum evaporation mask has been arranged, and alpha-NPD of the above-mentioned structure expression was formed in thickness of 30nm under the vacuum of  $10^{-4}$  or less Pa with the vacuum deposition method. The vacuum evaporation rate was carried out in 0.1nm/second.

[0109] Furthermore, the compound of above-mentioned structure-expression (15)-1 was vapor-deposited in contact with the electron hole transportation layer. This structure expression (15) Thickness of the electron transport layer (\*\*\*\*\*) which consists of a compound of -1 was also set to 30nm, and the vacuum evaporation rate was made respectively in 0.2nm/second.

[0110] Furthermore, the bathocuproine of the above-mentioned structure expression was vapor-deposited in contact with the luminous layer as a hole blocking layer ingredient. The thickness of this hole blocking layer that consists of bathocuproine set to 15nm, and the vacuum evaporation rate was carried out

in 0.1nm/second.

[0111] Furthermore, Alq3 of the above-mentioned structure expression was vapor-deposited in contact with the hole blocking layer as an electron transport layer ingredient. Thickness of this electron transport layer that consists of Alq3 was also set to 30nm, and the vacuum evaporation rate was carried out in 0.2nm/second.

[0112] The cascade screen of Mg and Ag was adopted as a cathode material, and by vacuum evaporation, this was also formed in the thickness of 50nm (Mg) and 150nm (Ag film) as vacuum evaporation rate 1nm/a second, and produced the \*\*\*\* organic electroluminescence devices shown in drawing 8 .

[0113] Thus, forward bias direct current voltage was applied to the organic electroluminescence devices of the produced example 11 under nitrogen-gas-atmosphere mind, and the luminescence property was evaluated. The luminescent color was red, and as a result of performing spectrometry like an example 10, it obtained the spectrum which has a luminescence peak near 710nm. Moreover, when the electrical-potential-difference-measurement of luminance was performed, the brightness of 170 cd/m<sup>2</sup> was obtained by 8V.

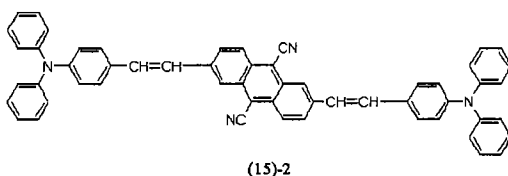
[0114] After producing these organic electroluminescence devices, although it was left for one month under nitrogen-gas-atmosphere mind, component degradation was not observed. Moreover, when energizing a current value

uniformly, carrying out continuation luminescence and carrying out forcible degradation by initial brightness 50 cd/m<sup>2</sup>, it was 140 hours until brightness was halved.

[0115] Example 12 this example is an example which produced the organic electroluminescence devices which used the compound of following structure-expression (15)-2 as an electronic transportability luminous layer among the above-mentioned styryl compounds of a general formula [I].

[0116]

[Formula 36] Structure expression (15) -2 :



[0117] Layer structure and the forming-membranes method produced organic electroluminescence devices based on the example 11.

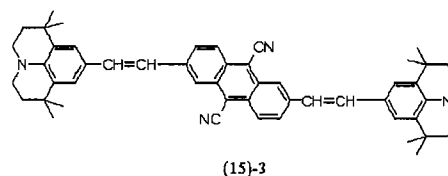
[0118] Thus, forward bias direct current voltage was applied to the organic electroluminescence devices of the produced example 12 under nitrogen-gas-atmosphere mind, and the luminescence property was evaluated. The luminescent color was red, and as a result of performing spectrometry like an example 10, it obtained the spectrum which has a luminescence peak near 750nm. Moreover, when the electrical-potential-difference-measurement of

luminance was performed, the brightness of 100 cd/m<sup>2</sup> was obtained by 8V.

[0119] After producing these organic electroluminescence devices, although it was left for one month under nitrogen-gas-atmosphere condition, component degradation was not observed. Moreover, when energizing a current value uniformly, carrying out continuation luminescence and carrying out forcible degradation by initial brightness 50 cd/m<sup>2</sup>, it was 100 hours until brightness was halved.

[0120] Example 13 this example is an example which produced the organic electroluminescence devices which used the compound of following structure-expression (15)-3 as an electronic transportability luminous layer among the above-mentioned styryl compounds of a general formula [I].

[0121]



[Formula 37] Structure expression (15) -3 :

[0122] Layer structure and the forming-membranes method produced organic electroluminescence devices based on the example 11.

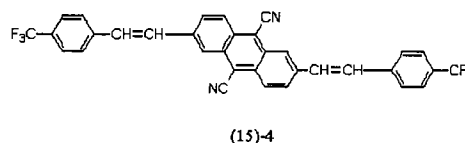
[0123] Thus, forward bias direct current voltage was applied to the organic electroluminescence devices of the produced example 13 under

nitrogen-gas-atmosphere mind, and the luminescence property was evaluated. The luminescent color was red, and as a result of performing spectrometry like an example 10, it obtained the spectrum which has a luminescence peak near 730nm. Moreover, when the electrical-potential-difference-measurement of luminance was performed, the brightness of 100 cd/m<sup>2</sup> was obtained by 8V.

[0124] After producing these organic electroluminescence devices, although it was left for one month under nitrogen-gas-atmosphere mind, component degradation was not observed. Moreover, when energizing a current value uniformly, carrying out continuation luminescence and carrying out forcible degradation by initial brightness 50 cd/m<sup>2</sup>, it was 150 hours until brightness was halved.

[0125] Example 14 this example is an example which produced the organic electroluminescence devices which used the compound of following structure-expression (15)-4 as an electronic transportability luminous layer among the above-mentioned styryl compounds of a general formula [I].

[0126]



[Formula 38] Structure expression (15) -4 :

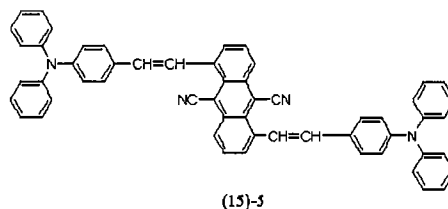
[0127] Layer structure and the forming-membranes method produced organic

electroluminescence devices based on the example 11. Thus, forward bias direct current voltage was applied to the organic electroluminescence devices of the produced example 14 under nitrogen-gas-atmosphere condition, and the luminescence property was evaluated. The luminescent color was red, and as a result of performing spectrometry like an example 10, it obtained the spectrum which has a luminescence peak near 670nm. Moreover, when the electrical-potential-difference-measurement of luminance was performed, the brightness of 500 cd/m<sup>2</sup> was obtained by 8V.

[0128] After producing these organic electroluminescence devices, although it was left for one month under nitrogen-gas-atmosphere condition, component degradation was not observed. Moreover, when energizing a current value uniformly, carrying out continuation luminescence and carrying out forcible degradation by initial brightness 50 cd/m<sup>2</sup>, it was 400 hours until brightness was halved.

[0129] Example 15 this example is an example which produced the organic electroluminescence devices which used the compound of following structure-expression (15)-5 as an electronic transportability luminous layer among the above-mentioned styryl compounds of a general formula [I].

[0130]



[Formula 39] Structure expression (15) -5 :

[0131] Layer structure and the forming-membranes method produced organic electroluminescence devices based on the example 11.

[0132] Thus, forward bias direct current voltage was applied to the organic electroluminescence devices of the produced example 15 under nitrogen-gas-atmosphere mind, and the luminescence property was evaluated.

The luminescent color was red, and as a result of performing spectrometry like an example 10, it obtained the spectrum which has a luminescence peak near 680nm. Moreover, when the electrical-potential-difference-measurement of luminance was performed, the brightness of 300 cd/m<sup>2</sup> was obtained by 8V.

[0133] After producing these organic electroluminescence devices, although it was left for one month under nitrogen-gas-atmosphere mind, component degradation was not observed. Moreover, when energizing a current value uniformly, carrying out continuation luminescence and carrying out forcible degradation by initial brightness 50 cd/m<sup>2</sup>, it was 170 hours until brightness was halved.

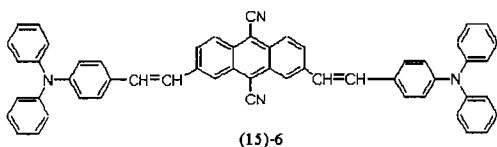
[0134] Example 16 this example is an example which produced the organic



electroluminescence devices which used the compound of following structure-expression (15)-6 as an electronic transportability luminous layer among the above-mentioned styryl compounds of a general formula [I].

[0135]

[Formula 40] Structure expression (15) -6 :



[0136] Layer structure and the forming-membranes method produced organic electroluminescence devices based on the example 11.

[0137] Thus, forward bias direct current voltage was applied to the organic electroluminescence devices of the produced example 16 under nitrogen-gas-atmosphere mind, and the luminescence property was evaluated.

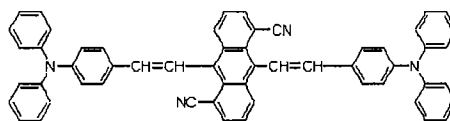
The luminescent color was red, and as a result of performing spectrometry like an example 10, it obtained the spectrum which has a luminescence peak near 640nm. Moreover, when the electrical-potential-difference-measurement of luminance was performed, the brightness of 700 cd/m<sup>2</sup> was obtained by 8V.

[0138] After producing these organic electroluminescence devices, although it was left for one month under nitrogen-gas-atmosphere mind, component degradation was not observed. Moreover, when energizing a current value

uniformly, carrying out continuation luminescence and carrying out forcible degradation by initial brightness 50 cd/m<sup>2</sup>, it was 300 hours until brightness was halved.

[0139] Example 17 this example is an example which produced the organic electroluminescence devices which used the compound of following structure-expression (15)-7 as an electronic transportability luminous layer among the above-mentioned styryl compounds of a general formula [I].

[0140]



[Formula 41] Structure expression (15) -7 :

(15)-7

[0141] Layer structure and the forming-membranes method produced organic electroluminescence devices based on the example 11.

[0142] Thus, forward bias direct current voltage was applied to the organic electroluminescence devices of the produced example 17 under nitrogen-gas-atmosphere mind, and the luminescence property was evaluated. The luminescent color was red, and as a result of performing spectrometry like an example 10, it obtained the spectrum which has a luminescence peak near 650nm. Moreover, when the electrical-potential-difference-measurement of luminance was performed, the brightness of 690 cd/m<sup>2</sup> was obtained by 8V.

[0143] After producing these organic electroluminescence devices, although it was left for one month under nitrogen-gas-atmosphere condition, component degradation was not observed. Moreover, when energizing a current value uniformly, carrying out continuation luminescence and carrying out forcible degradation by initial brightness 50 cd/m<sup>2</sup>, it was 350 hours until brightness was halved.

[0144]

[Function and Effect of the Invention] Since at least one sort of a styryl compound expressed with said organic layer by said general formula (1) or [I] is contained in the organic electroluminescence devices by which the organic layer which has a luminescence field is prepared between an anode plate and cathode according to the organic electroluminescence devices of this invention, it becomes possible to offer the organic electroluminescence devices which have stable red luminescence by high brightness.

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## DESCRIPTION OF DRAWINGS

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[Brief Description of the Drawings]

[Drawing 1] It is the important section outline sectional view of an example of the

organic electroluminescence devices based on this invention.

[Drawing 2] It is the important section outline sectional view of other examples of

.\*\*\*\* organic electroluminescence devices.

[Drawing 3] It is the important section outline sectional view of other examples of

\*\*\*\* organic electroluminescence devices.

[Drawing 4] It is the important section outline sectional view of other examples of

\*\*\*\* organic electroluminescence devices.

[Drawing 5] It is the important section outline sectional view of other examples of

\*\*\*\* organic electroluminescence devices.

[Drawing 6] It is the important section outline sectional view of other examples of

\*\*\*\* organic electroluminescence devices.

[Drawing 7] It is the important section outline sectional view of other examples of

\*\*\*\* organic electroluminescence devices.

[Drawing 8] It is the important section outline sectional view of the example of

further others of \*\*\*\* organic electroluminescence devices.

[Drawing 9] It is the block diagram of the full color flat-surface display using \*\*\*\*

organic electroluminescence devices.

[Drawing 10] It is the emission spectrum Fig. of the organic electroluminescence

devices by the example 1 of this invention.

[Drawing 11] It is the electrical-potential-difference-brightness property Fig. of

the organic electroluminescence devices by the \*\*\*\* example 1.

[Drawing 12] It is the emission spectrum Fig. of the organic electroluminescence devices by the example 2 of this invention.

[Drawing 13] It is the electrical-potential-difference-brightness property Fig. of the organic electroluminescence devices by the \*\*\*\* example 2.

[Drawing 14] It is the emission spectrum Fig. of the organic electroluminescence devices by the example 3 of this invention.

[Drawing 15] It is the electrical-potential-difference-brightness property Fig. of the organic electroluminescence devices by the \*\*\*\* example 3.

[Drawing 16] It is the emission spectrum Fig. of the organic electroluminescence devices by the example 5 of this invention.

[Drawing 17] It is the electrical-potential-difference-brightness property Fig. of the organic electroluminescence devices by the \*\*\*\* example 5.

[Description of Notations]

1 [ -- An organic layer, 6 / -- An electron hole transportation layer, 7 / -- An electron transport layer, 8 / -- A power source, 10 / -- An electron hole transportation layer, 11 / -- A luminous layer, 12 / -- An electron transport layer, 14 / -- A luminance-signal circuit, 15 / -- A control circuit, 20 / -- Luminescence light, 21 / -- A hole (electron hole) blocking layer, A, B, C, D / -- Organic electroluminescence devices ] -- A substrate, 2 -- transparent electrode (anode

plate), 3 -- Cathode, 4 -- A protective coat, 5, 5a, 5b